PB-218 870

# TRANSPORTATION CONTROLS TO REDUCE MOTOR VEHICLE EMISSIONS IN SALT LAKE CITY, UTAH

Fred Winkler

GCA Corporation

Prepared for:

Environmental Protection Agency

December 1972

DISTRIBUTED BY:

NTIS
National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

APTD-1445

PB 218 870

# TRANSPORTATION CONTROLS TO REDUCE MOTOR VEHICLE EMISSIONS IN SALT LAKE CITY, UTAH

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
U S Department of Commerce
Springfield VA 22151

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Water Programs
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

**BIBLIOGRAPHIC DATA SHEET**

**1. Report No.** APTD-1445

**2.**

**3. Recipient's Accession No.** PB-218 870

**4. Title and Subtitle** Transportation Controls to Reduce Motor Vehicle Emissions in Salt Lake City, Utah.

**5. Report Date** December 1972

**6.**

**7. Author(s)** Land Use Planning Branch

**8. Performing Organization Rept. No.**

**9. Performing Organization Name and Address**
GCA Corporation
GCA Technology Division
Bedford, Mass.

**10. Project/Task/Work Unit No.** DU-72-B895

**11. Contract/Grant No.** 68-02-0041

**12. Sponsoring Organization Name and Address**
Environmental Protection Agency
Office of Air Quality Planning & Standards
Research Triangle Park, N.C. 27711

**13. Type of Report & Period Covered** Final Report 8/14/72 to 12/15/72

**14.**

**15. Supplementary Notes** Prepared to assist in the development of transportation control plans by those State Governments demonstrating that National Ambient Air Quality Standards cannot be attained by implementing emission standards for stationary sources only.

**16. Abstracts**

The document demonstrates the nature of the Air Quality problem attributed to motor vehicle operation, the magnitude of the problem and a strategy developed to neutralize these effects in order that National Ambient air quality standard may be attained and maintained.

**17. Key Words and Document Analysis. 17a. Descriptors**

Motor Vehicle emitted pollutants - air pollutants originating within a motor vehicle and released to the atmosphere.

National Ambient Air Quality Standards - Air Quality Standards promulgated by the Environmental Protection Agency and published as a Federal Regulation in the Federal Register.

**17b. Identifiers/Open-Ended Terms**

VMT - Vehicle Miles Traveled

Vehicle Mix - distribution of motor vehicle population by age group.
LDV - light duty vehicle - less than 6500 lbs.
MDV - heavy duty vehicle - greater than 6500 lbs.

**17c. COSATI Field/Group** Environmental Quality Control of Motor Vehicle Pollutants

**18. Availability Statement** For release to public

**19. Security Class (This Report)** UNCLASSIFIED

**20. Security Class (This Page)** UNCLASSIFIED

**21. No. of Pages** 184

**22. Price** $3.00-0.95

FORM NTIS-35 (REV. 3-72)

USCOMM-DC 14952-P72

I-a

APTD-1445

# TRANSPORTATION CONTROLS TO REDUCE MOTOR VEHICLE EMISSIONS IN SALT LAKE CITY, UTAH

Prepared by

GCA Corporation
GCA Technology Division
Bedford, Massachusetts

Contract No. 68-02-0041

EPA Project Officer: Fred Winkler

Prepared for
ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Water Programs
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

December 1972

I-6

The APTD (Air Pollution Technical Data) series of reports is issued by the Office of Air Quality Planning and Standards, Office of Air and Water Programs, Environmental Protection Agency, to report technical data of interest to a limited number of readers. Copies of APTD reports are available free of charge to Federal employees, current contractors and grantees, and non-profit organizations - as supplies permit - from the Air Pollution Technical Information Center, Environmental Protection Agency, Research Triangle Park, North Carolina 27711, or may be obtained, for a nominal cost, from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22151.

This report was furnished to the Environmental Protection Agency by GCA Corporation, Bedford, Massachusetts, in fulfillment of Contract No. 68-02-0041. The contents of this report are reproduced herein as received from GCA Corporation. The opinions, findings, and conclusions expressed are those of the author and not necessarily those of the Environmental Protection Agency.

Publication No. APTD-1445

## Acknowledgements

Many individuals and several organizations have been helpful in carrying out this study; for these contributions the GCA Technology Division extends its sincere gratitude.

Continued project direction and guidance were given by Mr. Fred Winkler (Project Officer) and Mr. Dave Tamny of the Land Use Planning Branch, EPA, Durham, North Carolina, and Mr. Dale Wells (Co-Project Officer) of EPA Region VIII.

Many members of local and state agencies supplied data and critical analysis to the study.

Wilbur Smith and Associates, Inc. and Abt Associates, Inc. acted as subcontractors to GCA Technology Division and supplied major input to the study especially in the areas of traffic data, control strategies and implementation obstacles.

## TABLE OF CONTENTS

| Section | Title | Page |
|---|---|---|
| I | INTRODUCTION AND SUMMARY | I-1 |
| | A. BACKGROUND | I-1 |
| | B. PURPOSE, SCOPE AND LIMITATIONS OF STUDY | I-1 |
| | C. CONTENT OF REPORT | I-3 |
| | D. SUMMARY OF PROBLEM AND REQUIRED TRANSPORTATION CONTROLS | I-5 |
| II | VERIFICATION AND ASSESSMENT OF AIR POLLUTION PROBLEM | II-1 |
| | A. OUTLINE OF METHODOLOGY | II-1 |
| | 1. General | II-1 |
| | 2. Methodology for Carbon Monoxide | II-2 |
| | 3. Discussion of Methodology for Carbon Monoxide | II-4 |
| | 4. Methodology and Discussion for Oxidants | II-8 |
| | B. DISCUSSION OF 1970-1972 AIR QUALITY LEVELS | II-9 |
| | 1. Natural Features Affecting Pollution Potential | II-9 |
| | 2. Location and Type of Instrumentation | II-11 |
| | 3. Review of Air Quality Data | II-12 |
| | 4. Impact of Stationary Sources | II-26 |
| | 5. Required Air Quality Improvement | II-29 |
| | C. DISCUSSION OF VEHICLE MILES OF TRAVEL | II-31 |
| | 1. General | II-31 |
| | 2. Traffic Densities | II-34 |
| | 3. Traffic Variations | II-34 |
| | 4. Vehicle Type | II-36 |
| | 5. Trip Purpose | II-36 |
| | 6. Trip Length | II-41 |
| | 7. Average Daily Driver Trip Ends | II-41 |
| | 8. Core Area Vehicle Miles of Travel | II-41 |
| | D. DERIVATION OF 1977 AIR QUALITY LEVELS | II-47 |
| | 1. General | II-47 |
| | 2. Estimation of CO Levels | II-54 |
| | 3. Estimation of Oxidant Levels | II-59 |
| | E. DISCUSSION OF 1978 AND 1979 CARBON MONOXIDE LEVELS | II-66 |
| | F. SUMMARY OF PROBLEM AND CONCLUSIONS | II-66 |
| III | EVALUATION OF CANDIDATE TRANSPORTATION CONTROLS | III-1 |
| | A. GENERAL | III-1 |

## TABLE OF CONTENTS (Cont.)

| Section | Title | Page |
|---|---|---|
| III (Cont.) | B. MOTOR VEHICLE INSPECTION PROGRAM | III-2 |
| | 1. Statewide Emission Inspection Program in conjunction with Vehicle Safety Inspection | III-2 |
| | 2. Regional Inspection Program-Air Pollution Specific | III-6 |
| | 3. Transferred Motor Vehicle Inspection Program | III-6 |
| | 4. Spot Check Program | III-7 |
| | 5. Inspection Test Procedures | III-7 |
| | 6. Impact on Vehicle Emissions | III-15 |
| | 7. Cost Analyses | III-17 |
| | C. RETROFIT REQUIREMENT | III-19 |
| | D. TRAFFIC FLOW IMPROVEMENTS | III-24 |
| | 1. Traffic Signal System | III-25 |
| | 2. Impact on Vehicle Emissions | III-25 |
| | E. PERIPHERAL PARKING | III-29 |
| | 1. General | III-29 |
| | 2. Impact on Vehicle Emissions | III-32 |
| | F. IMPROVED MASS TRANSIT | III-33 |
| | 1. General | III-33 |
| | 2. Impact on Vehicle Emissions | III-35 |
| | G. OTHER ALTERNATE STRATEGIES | III-36 |
| | 1. Prohibit Traffic During Certain Periods of the Day and in Specified Areas | III-36 |
| | 2. Restrict Curb Parking | III-36 |
| | 3. Staggered Work Hours | III-37 |
| | 4. Car Pooling | III-37 |
| | 5. Reduction in Truck VMT | III-38 |
| IV | SELECTION OF TRANSPORTATION CONTROLS AND ESTIMATE OF AIR QUALITY IMPACT | IV-1 |
| | A. RECOMMENDED STRATEGY | IV-1 |
| | B. AIR QUALITY IMPACT | IV-2 |
| V | OBSTACLES TO IMPLEMENTATION OF SELECTED CONTROLS | V-1 |
| | A. INTRODUCTION AND SUMMARY | V-1 |
| | B. METHODOLOGY | V-2 |

TABLE OF CONTENTS (Cont.)

| Section | Title | Page |
|---|---|---|
| V (Cont.) | C. ASSESSMENT OF PROPOSED TRANSPORTATION CONTROL STRATEGIES | V-3 |
| | 1. Recommended Strategy: (Traffic Flow Improvements) | V-3 |
| | 2. Other Candidate Strategies | V-6 |
| VI | SURVEILLANCE REVIEW PROCESS | VI-1 |
| | A. TRAFFIC SURVEILLANCE METHODS | VI-1 |
| | 1. Estimated Traffic Growth | VI-2 |
| | 2. Estimated Speeds | VI-3 |
| | B. AIR QUALITY SURVEILLANCE | VI-4 |
| | C. SURVEILLANCE AND REVIEW MILESTONES | VI-6 |
| APPENDIX A | 1971-1977 VEHICLE MILES OF TRAVEL | A-1 |
| APPENDIX B | TRAVEL DENSITIES | B-1 |
| APPENDIX C | TABULATIONS OF VEHICULAR EMISSIONS | C-1 |
| APPENDIX D | QUESTIONNAIRE - TESTING THE FEASIBILITY OF CONTROL STRATEGIES | D-1 |
| APPENDIX E | LIST OF INTERVIEWEES | E-1 |

# LIST OF TABLES

| Table | Title | Page |
|---|---|---|
| I-1 | SUMMARY EMISSION AND CO AIR QUALITY DATA FOR SALT LAKE CITY (ZONE H) | I-7 |
| II-1 | HIGHEST AND SECOND HIGHEST CO LEVELS OBSERVED AT SALT LAKE CITY | II-14 |
| II-2 | MAXIMUM 1-HOUR CO CONCENTRATIONS (IN PPM) OBSERVED IN SALT LAKE CITY DURING THE PERIOD 1 JULY 1971 TO 30 JUNE 1972 | II-18 |
| II-3 | MAXIMUM 8-HOUR CO CONCENTRATION (IN PPM) OBSERVED IN SALT LAKE CITY DURING THE PERIOD 1 JULY 1971 to 30 JUNE 1972. | II-19 |
| II-4 | HIGHEST TOTAL OXIDANT LEVELS OBSERVED AT SALT LAKE CITY | II-20 |
| II-5 | MAXIMUM 1-HOUR OXIDANT CONCENTRATIONS (IN PPM) OBSERVED IN SALT LAKE CITY DURING THE PERIOD 1 JULY 1971 TO 30 JUNE 1972 | II-24 |
| II-6 | MAJOR POINT SOURCES OF CO EMISSIONS SALT LAKE COUNTY 1970 | II-27 |
| II-7 | MAJOR POINT SOURCES OF HC EMISSIONS SALT LAKE COUNTY 1970 | II-28 |
| II-8 | HOURLY TRAFFIC VARIATIONS | II-35 |
| II-9 | ESTIMATED TRAFFIC VARIATIONS (Core Area) | II-37 |
| II-10 | ESTIMATED TRAFFIC VARIATIONS (Freeway) | II-38 |
| II-11 | ESTIMATED TRAFFIC VARIATIONS (Total Study Area) | II-39 |
| II-12 | AUTO TRIPS BY PURPOSE INTERNAL SURVEY - 1960) | II-40 |
| II-13 | COMPARISON OF TRIP PURPOSE ALL MODEL VERSUS TRANSIT | II-42 |
| II-14 | AUTO DRIVER TRIP LENGTHS BY PURPOSE - 1960 INTERNAL SURVEY | II-43 |
| II-15 | AVERAGE DAILY DRIVER TRIP ENDS - BY RESIDENTS - 1960 CLASSIFIED BY TYPE VEHICLE | II-44 |
| II-16 | DAILY VEHICLE MILES OF TRAVEL | II-46 |
| II-17 | 1971 VEHICLE MILES OF TRAVEL BY TIME PERIOD AND TYPE OF VEHICLE | II-48 |
| II-18 | 1977 VEHICLE MILES OF TRAVEL BY TIME PERIOD AND TYPE OF VEHICLE | II-49 |
| II-19 | 1978 VEHICLE MILES OF TRAVEL BY TIME PERIOD AND TYPE OF VEHICLE | II-50 |
| II-20 | 1979 VEHICLE MILES OF TRAVEL BY TIME PERIOD AND TYPE OF VEHICLE | II-51 |
| II-21 | CO EMISSION ESTIMATES FOR SALT LAKE COUNTY IN 1970 | II-56 |

## LIST OF TABLES (Cont.)

| Table | Title | Page |
|---|---|---|
| II-22 | SUMMARY DATA FOR ZONE H (CO) | II-58 |
| II-23 | HYDROCARBON EMISSION ESTIMATES FOR SALT LAKE COUNTY IN 1970 | II-62 |
| II-24 | SUMMARY DATA FOR CORE AREA (HYDROCARBONS-OXIDANTS) | II-64 |
| III-1 | IMPACT OF TRANSPORTATION CONTROLS ON TRAVEL PATTERNS AND MOTOR VEHICLE EMISSIONS | III-3 |
| III-2 | TEST PROCEDURE SUMMARY | III-16 |
| III-3 | ESTIMATED COST EFFECTIVENESS USING SEVERAL TYPES OF INSPECTION/MAINTENANCE | III-18 |
| III-4 | VEHICLE MILES OF TRAVEL BY AGE OF VEHICLE | III-21 |
| III-5 | VEHICLE DISTRIBUTION BY MODEL YEAR (SALT LAKE COUNTY) | III-23 |
| III-6 | COMPUTER CENTRAL SIGNAL CONTROL SYSTEM | III-26 |
| IV-1 | SUMMARY OF EMISSION DENSITY AND AIR QUALITY ESTIMATES IN 1977 BASED ON TRAFFIC FLOW IMPROVEMENTS | IV-4 |
| VI-1 | DAILY VEHICLE MILES OF TRAVEL 1971-1972 | VI-2 |
| VI-2 | ESTIMATED SPEEDS 1971-1972 | VI-3 |

## LIST OF FIGURES

| Figure | Title | Page |
|---|---|---|
| II-1 | Diurnal variation of average CO concentration in Salt Lake City by season. | II-15 |
| II-2 | Maximum 1-hour CO concentration observed each hour of the day in Salt Lake City by season. | II-17 |
| II-3 | Diurnal variation of average oxidant concentrations in Salt Lake City by season. | II-21 |
| II-4 | Maximum 1-hour oxidant concentration observed each hour of the day in Salt Lake City by season. | II-23 |
| II-5 | Monthly variations in CO and oxidant concentrations in Salt Lake City. | II-25 |
| II-6 | Traffic zones Salt Lake City. | II-32 |
| II-7 | Traffic volumes - 1971; Salt Lake City. | II-33 |
| II-8 | Core area sectors - Salt Lake City. | II-45 |
| II-9 | Travel densities (thousands of miles per square mile) for zones outside the Core Area . | II-52 |
| II-10 | Travel densities (thousands of miles per square mile) for zones inside Core Area. | II-53 |
| II-11 | CO emission densities (kg/8-hour/mi$^2$) for 1971 (upper) and 1977 (lower). Value in parentheses (Zone H) is emission density for 1970. | II-55 |
| II-12 | Hydrocarbon emission densities (kg/3-hour/mi$^2$) for 1971 (upper) and 1977 (lower). Value in parentheses (Zone H) is emission density for 1970. | II-61 |
| II-13 | CO emission densities (kg/8-hour/mi$^2$) for 1978 (upper) and 1979 (lower). | II-67 |
| III-1 | Cost-benefit comparisons. | III-20 |
| IV-1 | CO emission densities (kg/8-hr/mi$^2$) for 1977 based on traffic flow improvement. | IV-3 |
| VI-1 | Projected 8-hour CO concentrations based on 1970 data (above) and 1971 data (below). | VI-5 |
| VI-2 | Surveillance review milestones; Salt Lake City. | VI-7 |

# I. INTRODUCTION AND SUMMARY

## A. BACKGROUND

States were required to submit implementation plans by January 30, 1972, that contained control strategies demonstrating how the national ambient air quality standards would be achieved by 1975. Many urban areas could not achieve the carbon monoxide and oxidant air quality standards by 1975 or even 1977 through the expected emission reductions from the 1975 exhaust systems control. Major difficulty was encountered by many states in the formulation of implementation plans that included transportation control strategies (including, for example, retrofit and inspection, gaseous fuel conversions, traffic flow improvements, increased mass transit usage, car pools, motor vehicle restraints, and work schedule changes). Because of the complex implementation problems associated with transportation controls, states were granted until February 15, 1973 to study and select a combination of transportation controls that demonstrated how the national air quality standards would be achieved and maintained by 1977.

## B. PURPOSE, SCOPE AND LIMITATIONS OF STUDY

The purpose of the study reported on herein was to identify and develop transportation control strategies that will achieve the carbon monoxide and oxidant air quality standards required to be met by the State of Utah in the Salt Lake City urban area by the year 1977. The results of the study were to help determine the initial direction that the State of Utah should take in selecting feasible and effective transportation controls. It was anticipated that the control strategies outlined in this study would be periodically revised in the coming years. The State's Implementation Plan was analyzed to verify and assess the severity of the carbon monoxide and oxidant pollutant problems, and the most promising transportation controls and their likely air quality impact were determined. Major implementation obstacles were noted after discussions with those agencies responsible for implementing the controls, and finally, a surveillance review process (January, 1973 - December, 1976, inclusive) was developed for EPA to use in monitoring implementation progress and air quality impact of transportation control strategies.

It should be noted that the study was carried out relying on the best data and techniques available during the period of the study and further, that a large number of assumptions were made as to the nature of future events. The 1977 air quality predictions were based on extant air quality data and on predicted stationary source emissions and predicted traffic patterns, and these predicted parameters themselves were based on anticipated emission control techniques, anticipated growth patterns, and the assumed outcome of unresolved legal and political decisions. Further, the development, ranking and selection of transportation controls were based on extant and predicted economic, sociological, institutional and legal considerations. Finally, the surveillance process presented in this report, although showing key checkpoints towards implementation of the recommended controls, is in itself dependent upon the same assumed pattern of future events.

It should be emphasized therefore, that to the extent that the time-scale of the recommended program permits, the conclusions and recommendations of this report should not be construed as a program which must be rigidly followed until 1977, but rather it should be regarded first, as a delineation as to what appears at the present time to be a feasible course of action to attain air quality goals, and secondly, as a framework upon which an optimum on-going program can be built as new data and techniques become available, as legal and political decisions are made, and as the assumptions as to future events are, or are not, validated.

## C. CONTENT OF REPORT

Section II of this report describes how the pollutant concentration levels which could be expected to occur in 1977 in the Salt Lake City area were predicted. These levels were determined by an adaptation of the proportional model using motor vehicle emissions from traffic patterns predicted for 1977 together with predicted non-vehicular emissions for 1977 obtained from state agencies. Comparison of these predicted 1977 air pollutant concentrations with the national air quality standards enabled the computation of the motor vehicle emissions which would result in the air quality standards being met, and therefore, to what extent, if any, reductions in the predicted 1977 motor vehicle emissions would be required. In order to determine the pollutant concentration(s) which was to serve as the basis for the proportional model, an intensive evaluation of all existing meteorological and air quality data was performed.

The final determination as to the concentration value used was made in close cooperation with representatives of local and state agencies and of EPA.

Section III describes how candidate control strategies were developed, evaluated and ranked having regard to technical, legal, institutional, sociological and economic criteria. An important feature of this task was the continuing interaction between, on one hand, the GCA study team, and on the other hand, representatives of local and state environmental planning and transportation agencies, concerned citizen's groups, and EPA representatives.

Section IV presents the rationale for selecting the optimum package of controls necessary to achieve the required reduction in motor vehicle emissions and also presents the confirmed effect on air quality.

Section V deals in detail with the obstacles to the implementation of the selected strategies. Since the obstacles to implementation were important criteria in the evaluation of the feasibility of candidate transportation controls, there is considerable discussion on such obstacles in earlier sections.

Section VI presents the surveillance review process which will enable EPA to monitor the implementation progress and air quality impact of the recommended strategies. Curves showing predicted air quality levels for the years 1973 to 1977 and beyond are presented, based on the Federal Motor Vehicle Control Program alone, and on the federal program in conjunction with the recommended transportation control strategy. These curves provide a basic indication of the way in which air quality should improve as time passes and as controls are implemented. In addition, important checkpoints are provided delineating the salient actions which must be taken in order to implement the strategies, such as the obtaining of the necessary financing and legislation. Further, important background assumptions, such as growth rate are identified, and methodologies supplied, to provide verification that these assumptions are in fact, validated during the course of the program.

It should be noted, however, that the surveillance process thus provided is of necessity based on the problem, and the concomitant transportation controls as they are presently perceived. An equally important part of any surveillance process is the continuing reassessment of both the problem itself and the appropriateness of the required controls. As was discussed earlier in this Introduction, the present study employed a whole range of both of extant data and techniques, and also of assumptions about the course of future events. This data base should be continuously reviewed as new information becomes available. Thus, although the key background parameters are called out in the Surveillance Process, a thorough and continuing review of all the data, techniques and assumptions contained in this report will be required to properly update the problem definition and appropriate control measures.

## D. SUMMARY OF PROBLEM AND REQUIRED TRANSPORTATION CONTROLS

The analysis described in the body of this report indicates a need for transportation control strategies to reduce CO emissions within

Salt Lake City's central business district if the national 8-hour average standard for CO concentration is to be met by 1977. On the other hand, the available data indicates that the oxidant standard and the 1-hour average CO standard will be met throughout the urban area by means of the Federal Motor Vehicle Control Program alone.

After evaluating the probable effectiveness and feasibility of a large number of possible controls, the recommended strategy selected is Traffic Flow Improvement, to be achieved principally by means of a computerized traffic signal system (TOPICS Improvement Project, No. 1). Current estimates show that the standards may be met in 1977 by means of this system. However, it is recommended that consideration be given to "back-up" strategies, including mass transit development, in the event that additional controls prove necessary. It is also recommended that the role of the automobile - in particular parking in the downtown area - be carefully re-evaluated.

Table I-1 summarizes the magnitude of the problem and the effect of the computerized traffic signal system on CO emissions in the area of principal concern. At the request of EPA, projections were made from two baseline years, 1970 and 1971. Results from both sets of calculations are presented in the table. It is emphasized again that the air quality estimates are "best estimates" based on available data and the proportional model. Also, experience shows that considerable variation in the maximum (or second highest) 8-hour concentration will be experienced at a given sampling location from year to year even under relatively con-

## TABLE I-1

## SUMMARY EMISSION AND CO AIR QUALITY DATA FOR SALT LAKE CITY (ZONE H)

| | Without Strategies | | | | | With Strategy (signal system) |
|---|---|---|---|---|---|---|
| | 1970 | 1971 | 1977 | 1978 | 1979 | 1977 |
| a) Emission Densities (kg/8 hr/mi$^2$) | | | | | | |
| Vehicular | 7878 | 7691 | 4156 | 3511 | 2975 | 3471 |
| Non-vehicular | 161 | 161 | 161 | 161 | 161 | 161 |
| Total | 8039 | 7852 | 4317 | 3672 | 3136 | 3632 |
| b) Air Quality (8-hr average in ppm) | | | | | | |
| Observed (2nd Highest) | 22 | 17 | | | | |
| Estimated | | | | | | |
| From 1970 data | | | 11.8 | 10.0 | 8.6 | 9.9 |
| From 1971 data | | | 9.3 | 8.0 | 6.8 | 7.9 |

c) Maximum Allowable Emission Level (kg/8 hr/mi$^2$)

| | Total | Non-vehicular | Vehicular |
|---|---|---|---|
| Estimated | | | |
| From 1970 data | 3289 | 161 | 3128 |
| From 1971 data | 4157 | 161 | 3996 |

d) Reduction in Vehicular Emissions from 1971 levels (percent)

| Reference Year | From Federal Motor Vehicle Control Program by 1977 | Additional Required by Strategies |
|---|---|---|
| 1970 | 46 | 13 |
| 1971 | 46 | 2 |

stant emission rates. Finally, in addition to the temporal variation in air quality at a given station, substantial spatial variations are to be expected within the CBD. The predicted concentrations are presented in tenths of a part per million simply to indicate the anticipated overall trend in air quality.

The analysis of hydrocarbon emissions indicated that emissions from motor vehicles will decrease by 52 percent between 1971 and 1977 as a result of the Federal Motor Vehicle Control Program, and that total emissions of hydrocarbons in a 14 square mile central zone of Salt Lake City will be about 30 percent below the allowable level in 1977.

# II. VERIFICATION AND ASSESSMENT OF AIR POLLUTION PROBLEM

## A. OUTLINE OF METHODOLOGY

### 1. General

The basic procedure employed was to develop, for the urban area of Salt Lake City, pollutant concentration levels which could be expected in 1977 without the application of transportation controls (the potential 1977 levels). Pollutant levels were determined by the proportional model using non-vehicular emissions supplied by state agencies and using vehicular emissions based on traffic data developed during the course of this study. More sophisticated techniques could not be employed due to the lack of suitable extant calibrated diffusion models, and the short time period of the contract which precluded the development of a suitable model and the required inputs. Comparison of potential 1977 air quality levels with the appropriate standard gave the allowable motor vehicle emissions in 1977, which in turn formed the basis for the development of transportation control strategies.

Emissions from non-vehicular sources were obtained from the State Implementation Plan. Emissions from vehicular sources were computed following the recommendations given in EPA draft publication An Interim Report on Motor Vehicle Emission Estimation by David S. Kircher and Donald P. Armstrong, dated October 1972. Air quality data for each sensor within the city area were reviewed and evaluated in close cooperation with state and local agencies. The instrumental method and sensor location was studied and records of instrument maintenance and calibration examined so as to identify questionable readings. Meteorological records were then examined and compared with seasonal and diurnal variations in air quality levels. Finally the pollutant concentration which would form the basis for the proportional rollback calculations was decided upon in concert with state and local agencies and EPA representatives. The year in which this concentration level occurred defined the base year for the proportional rollback calculations.

The detailed methodologies for carbon monoxide and oxidants are presented separately below.

### 2. Methodology for Carbon Monoxide

Because ambient concentrations of carbon monoxide at any given location appear to be highly dependent on carbon monoxide emissions in the near vicinity, it was felt that some justification existed for a modification of the proportional model. It was felt that in order to reduce ambient CO levels in, for example, a central business district (CBD), it would be more appropriate to roll back CO emissions in the CBD itself, rather than the entire air quality region. The assumption was therefore made that pollutant concentration in any given zone was directly proportional to the emission rate of that pollutant emission within that zone. Accordingly, the urban area was divided into traffic zones - about one square mile in area in the center of the city with increasingly larger zones towards the suburban areas.

The application of the proportional model, generalized for an urban area with multiple monitoring stations, comprises the following steps:

- Calculation of the total CO emission density (vehicular plus non-vehicular) for each zone in which CO concentrations are available for the baseline year. (In practice, baseline emission densities were calculated for all zones).
- Selection of the observed CO concentration for rollback computations at each monitoring station.
- Calculation of an emission density/concentration (e/c) ratio at each monitoring station.
- Calculation of the allowable emission density in each zone from the appropriate e/c ratio. (When measured e/c ratios differ from zone to zone, or within a single zone, the selection of an e/c ratio for general application is largely a matter of judgment.)
- Calculation of the total CO emission density for each zone for 1977 on the assumption that no transportation controls are imposed.
- Calculation, where required, of the reduction in emissions needed to meet the national air quality standard.

Although the principal contributing sources of CO to the urban area are motor vehicles, an attempt was made to apportion total CO emissions to vehicular and non-vehicular sources. Non-vehicular emissions for the years of interest were estimated from the State Implementation Plan which took into account predicted growth and predicted control strategies. The predicted control strategies were generally those that state agencies considered to be the maximum feasible, and therefore the predicted non-vehicular emissions were assumed to be irreducible for the purposes of this study. On the assumption that the predicted emission densities from non-vehicular sources were to be taken as irreducible, the allowable emissions from motor vehicles in each zone for the year of interest were then determined.

### 3. Discussion of Methodology for Carbon Monoxide

#### a. Modified Proportional Model

The applications and the limitations of the conventional proportional rollback method have been well documented and reviewed[*] and need not be discussed further here. The technique used in the present study was an extension of the conventional rollback technique to the extent that it was assumed first that the constant of proportionality between emissions and concentration may be derived from emissions emanating from the relatively small area around the sensor (the traffic zone), and second, that this constant of proportionality (the emission/concentration ratio) could be applied to determine pollutant concentrations in other zones of comparable area on the basis of the pollutant emissions in those zones.

Some justification of the first assumption can be found, for example, in recent work of Hanna[**] and Gifford[***] who demonstrate the dominance of urban pollution patterns by the distribution of the local area sources. The success of their urban diffusion model, in which concentration is simply directly proportional to the area source strength and inversely proportional to wind speed, is attributed largely to the relatively uniform distribution of emission within an urban area and the rate at which the effect of an area source upon a given receptor decreases with distance. In the proportional model, meteorological effects, such as wind speed, are assumed to be duplicated over one-year periods. The validity of the second assumption depends, in large part, upon the extent to which diffusion and transport parameters are uniform from zone to zone - a factor which could not be investigated because of the constraints of the program. Thus, it was felt that, in the absence of a more sophisticated technique, the use of this extension to the proportional model was justified first, to obtain some assessment as to whether the existing sensors were located in the "hot-spots", and second, to obtain some assurance that transportation strategies intended to reduce emission densities in one zone (to the level required to meet ambient standards) did not increase emission densities to unacceptable levels in adjacent zones. In many cities it was found that the sensors were, in fact, in the "hot spot" zones and also that the recommended transportation controls did not increase emissions in adjacent areas to unacceptable levels. Thus the final rollbacks were confined to the zones with a sensor within their boundaries and the extensions of the techniques to other non-sensor zones did not, therefore, play a primary role in the final computations.

---

[*] Noel de Nevers. Rollback Modeling, Basic and Modified. Draft Document, EPA, Durham, N.C. (August 1972).

[**] Hanna, S.R., "A Simple Method of Calculating Dispersion from Urban Area Sources," J. APCA 21, 774-777 (December 1971).

[***] Gifford, F.A., "Applications of a Simple Urban Pollution Model," (paper presented at the Conference on Urban Environment and Second Conference on Biometeorology of the Amer. Meteor. Soc., October 31 - November 2, 1972, Philadelphia, Pa.).

Experience in urban areas that had several sensors showed that the emission concentration ratio differed substantially from zone to zone and served to underline the fundamental limitations of the technique employed. An implicit assumption in the technique employed was that the air quality in a traffic zone could be fairly represented by one concentration level and that this level depended only upon the average emission density within that zone. The two major factors mitigating against this assumption are:

(a) Emission densities are not uniform across even a small traffic zone.

(b) Concentration levels are not uniform across the traffic zone partly because of the lack of uniformity of emission density and partly because the point surface concentrations are affected by micrometeorology and microtopography as well as emission density.

Considerable judgment had to be used, therefore, both in the derivation of e/c ratios and in their subsequent use. In heavily trafficked downtown areas the variation was judged not to be too great, so that the single recorded concentration might reasonably be expected to be representative of the zone's air quality and emission density. However, in suburban zones having overall low traffic densities, sensors were often found to be placed at very localized hot spots, such as a traffic circle, so that the recorded concentration levels were neither representative of the overall air quality nor of the overall emission density in the zone.

Accordingly, e/c ratios were generally derived from sensors in the central areas of the cities and applied to suburban areas for the prediction of 1977 concentration levels. This procedure gave air quality levels which were generally representative of the suburban zone. However it must be realized that control strategies based on this procedure, while they may ensure that the overall air quality in a suburban zone will not exceed ambient standards, do not preclude the occurrence of higher concentrations in very localized hot spots such as might occur in the immediate vicinity of a major traffic intersection.

The analysis of Salt Lake City data indicated that the single monitor in the urban area was at a representative location within the zone of maximum emissions and that rollback would be required within only a relatively small part of the city.

### b. Seasonal and Diurnal Variations

The CO observations showed that the 1-hour average concentration was much closer to the standard than the 8-hour average, so that controls required to meet the 8-hour standard would also result in the 1-hour standard being met. Examination of the diurnal variation of CO concentration and the daily traffic flow showed that strategies directed specifically at short period maximums (such as those observed during morning rush hour) were not particularly suited to the Salt Lake City area. During the fall and winter when the CO problem is most acute, the moderately high concentrations which develop by late afternoon tend to remain until after midnight, presumably as a result of strong nighttime inversions. Although seasonal variations in readings were noted, traffic data were not available on a seasonal basis, so that vehicle emissions were based on annual average work day traffic data.

### c. Background Concentration

Background concentration levels of CO were not taken into account. "Worst case" diffusion calculations indicated that the concentration of point sources upon the CBD could be safely neglected in the rollback calculations.

### 4. Methodology and Discussion for Oxidants

The technique employed for oxidants was basically the same as has just been described for CO with the major difference that only one, very much larger area, was used as the basis for the proportional rollback. Because of the length of time required for the formation of oxidants from hydrocarbon emissions, the relatively small areas used as the basis for CO could not be justified. The actual area used was largely a matter of judgment and comprised 14 square miles in the heart of the urban area.

The reductions in hydrocarbon emissions necessary to achieve oxidant ambient standards were obtained from Appendix J, Federal Register of August 14, 1971.

## B. DISCUSSION OF 1970-1972 AIR QUALITY LEVELS

### 1. Natural Features Affecting Pollution Potential

#### a. Topography

Salt Lake City is located at the northern end of the Salt Lake Valley. The valley is about 15 miles wide and 25 miles long. It is bordered on three sides by mountain ranges and opens toward the northwest to the Great Salt Lake. The Wasatch range to the east averages 10,000 feet above sea level and has peaks that extend to 12,000 feet. The Oquirrh range to the west has an average elevation of 8500 feet with peaks to 9700 feet. The southern end of the valley is bounded by a line of low hills about 5000 feet in elevation called the Traverse range. The valley floor rises gently from the Great Salt Lake, which has an elevation of about 4200 feet, to the foot of the mountains. Bench areas along the east and west sides of the valley mark the level of prehistoric Lake Bonneville. Numerous canyons open into the valley from the mountain ranges to the east and west. The principal industrial and commercial areas are located on the valley floor. Thickly settled residential areas extend up the lower slopes of the mountains to the east and north of the core area of the city.

#### b. Meteorology

Climatological statistics for Salt Lake City are based principally on observations from the Salt Lake Airport four miles west of the city center. As might be expected from a consideration of the major topographical features in the area, the most prevalent wind directions are from the south or southeast and from the north or northwest. This general pattern is typical of all seasons of the year. Because of the relatively large number of sunny days and clear nights with weak anticyclonic pressure gradients, there are pronounced thermally-driven mountain-valley wind circulations. Details of the wind regimes are undoubtedly quite complex and are not well documented by measurements. An additional meteorological phenomenon, also a feature of fair weather regimes, is the extremely large diurnal variation in the depth of the surface mixing layer. At night, in the presence of clear skies and low humidities, intense surface temperature inversions develop above the valley floor and the average depth of the surface mixing layer is of the order of 100 meters. During the day, as the result of solar heating, the average depth of the surface mixing layer varies from about 1.5 to 4 kilometers, depending on the season of the year.

The topographical features of the area form a natural basin within which pollutants generated in the valley tend to be confined. The pollution problem may become acute during stagnation periods when anticyclones become stationary over the region. Under these conditions, the air becomes very stable and vertical transfer of pollutants is severely restricted. At the same time, surface winds are light and are controlled largely by local circulations. During the night, air cooled by the mountain slopes drains into the valley and toward the Great Salt Lake. During the day, upslope winds develop due to heating of the mountain slopes. This reversible flow tends to advect pollutants back and forth across the valley, resulting in continuing accumulation during the period of stagnation.

Meteorological conditions are important not only in the transport and diffusion of motor vehicle pollutants, but also control the rate of production of photochemical oxidants. As a consequence, two periods of the year require special attention. The late fall and winter period contains the highest number of stagnating anticyclones and accompanying stable conditions. As a result, maximum CO concentrations may be expected during this part of the year. Because of less intense solar radiation and more extensive cloudiness during this period, however, the production of photochemical oxidants is limited and oxidant concentrations are generally low. In contrast, extremely stable conditions rarely occur in late spring and summer but the amount of solar radiation is at a maximum. Consequently, CO concentrations are generally low during this period but the levels of photochemical oxidants are higher than at any other time of the year.

## 2. Location and Type of Instrumentation

### a. Location of Monitor

The monitoring station for both CO and total oxidants is centrally located within Salt Lake City at 610 South and 2nd East. Both analyzers are located in a shelter on the roof of the County Health Building. The monitoring station is well exposed. Air flow to the station is not restricted by neighboring buildings. The height of the inlet tubes to the analyzers is about 10 meters above street level.

b. Type of Instrumentation

### CO Analyzer

An MSA NDIR carbon monoxide analyzer has been used throughout the observation period. The operation of this instrument is based on nondispersive infrared spectrometry which is the EPA reference method.

### Oxidant Analyzer

A Mast Ozone Meter has been used throughout the observation period. This instrument depends upon the oxidation of iodide to iodine and a subsequent coulometric reduction back to iodide for its operation. The units detect all oxidants reducible by the iodide ion unlike the ozone-specific EPA reference method (chemiluminescence). The analyzer is equipped with a filter tube to minimize interference from sulfur dioxide.

## 3. Review of Air Quality Data

a. General

CO and total oxidant concentrations observed at the Salt Lake City monitoring station during the one-year period from 1 July 1971 through 30 June 1972 have been reviewed and the maximum values observed during this period compared with those reported in the Implementation Plan for 1970. Additionally, seasonal and daily variations in the maximum concentrations during the July 1971-June 1972 period have been examined to provide possible guidance in developing traffic control strategies.

### b. CO Air Quality Data

Table II-1 gives the highest and second highest 1-hour and 8-hour average CO concentrations observed during 1970 and during the period from 1 July 1971 to 30 June 1972. Agreement between the two years is excellent. The second highest 1-hour concentration slightly exceeded the national standard during 1970, but did not exceed the standard during the second one-year period. Details of the observations made during the July 1971-June 1972 period follow.

The diurnal variation of CO concentration is shown in Figure II-1 for each of the four seasons. The diurnal pattern is similar in all seasons, but the amplitude of the variations is a function of the season. The concentration falls from about midnight to six o'clock in the morning, rises abruptly to a maximum about eight or nine o'clock, decreases to a second minimum about noon and remains low until the end of the afternoon or early evening when it increases to a second maximum which persists until about midnight. The onset of the evening maximum shifts substantially with season, occurring earliest in winter and latest in summer. The magnitudes of the morning and evening maximums decrease successively from fall to winter to summer to spring.

Figure II-2 is a plot of the highest 1-hour concentration observed during each hour of the day in each season. Concentrations are plotted on the hour ending the averaging period. The shape of the curves in Figure II-2 roughly follows the shape of the corresponding seasonal curves for average values shown in Figure II-1. One-hour

## TABLE II-1

## HIGHEST AND SECOND HIGHEST CO LEVELS OBSERVED AT SALT LAKE CITY

| Sampling Period | Concentration (ppm) | | | |
|---|---|---|---|---|
| | Highest | | 2nd Highest[*] | |
| | 1-hr | 8-hr | 1-hr | 8-hr[**] |
| Jan 1970 - Dec 1970 (Used in Implementation Plan) | 39 | 23 | 37 | 22 |
| July 1971 - June 1972 (Latest 1-yr data set) | 35 | 24 | 35 | 17 |

---

[*] Values are to be compared with the national standards of 35 ppm for 1 hour, and 9 ppm for 8 hours, which are not to be exceeded more than once a year.

[**] Based on independent 8-hour averages.

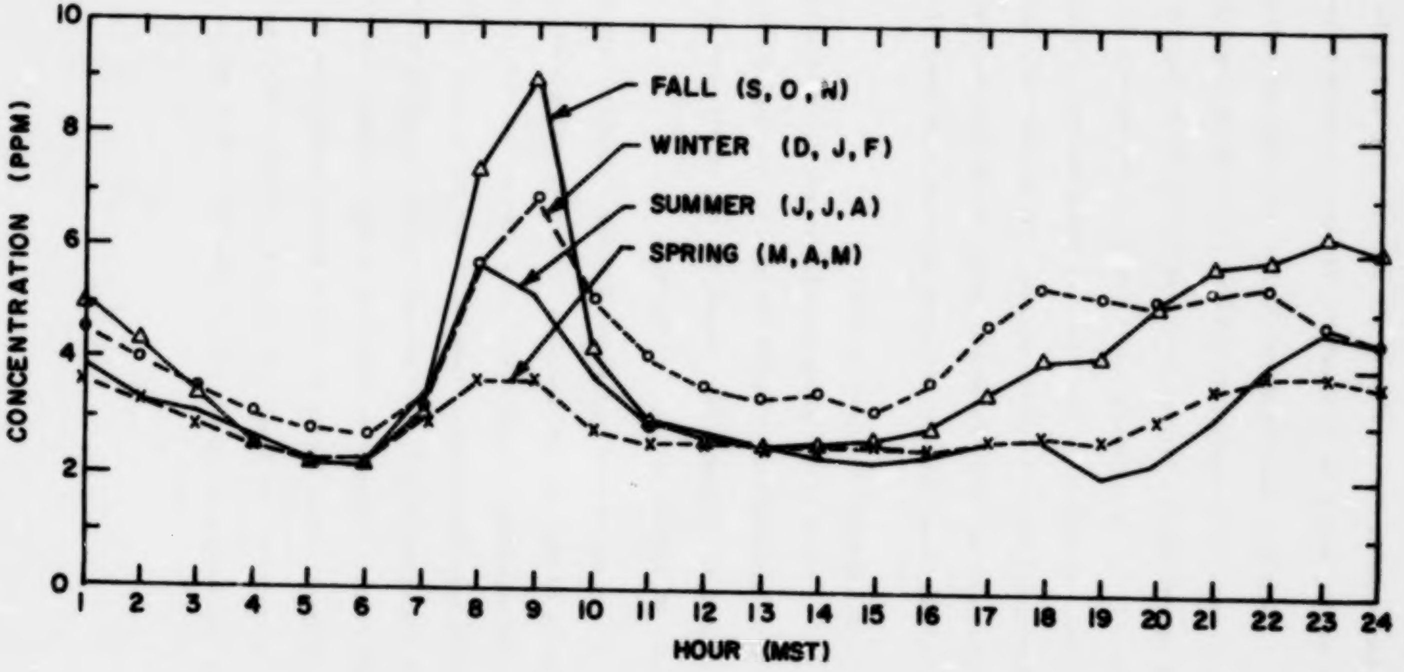


Figure II-1. Diurnal variation of average CO concentration in Salt Lake City by season.

concentrations reached levels of possible concern only during the fall and winter months, but at no time was the national standard exceeded.

Additional details of the diurnal and seasonal variation of CO concentration can be obtained from Table II-2 which gives the highest 1-hour concentration observed during each hour of the day for each month. Table II-3 is a similar presentation of the maximum 8-hour CO concentrations. As expected, the 8-hour standard was most frequently exceeded during the fall and winter months. May was the only month in which the standard was never exceeded. Also, during the one-year period, the 8-hour standard was exceeded at least twice on every hour of the day.

### c. Oxidant Air Quality Data

Table II-4 gives the highest and second highest 1-hour total oxidant concentrations observed during 1970 and during the period from 1 July 1971 to 30 June 1972. Values for the second year period are approximately 84 percent of the 1970 values.

The diurnal variation of oxidant concentration was examined for each month of the year and the data for months having similar diurnal patterns were combined. Figure II-3 is a plot of the results for the four modified seasonal periods. Concentrations are plotted on the hour ending the averaging period. The maximum diurnal variation occurs in the five "summer" months when solar radiation is most intense, and the minimum diurnal variation occurs during the three winter months when the influence of solar radiation is the least. As might be expected, the lowest value during the day occurs during the period from 0500 - 0700 MST in all

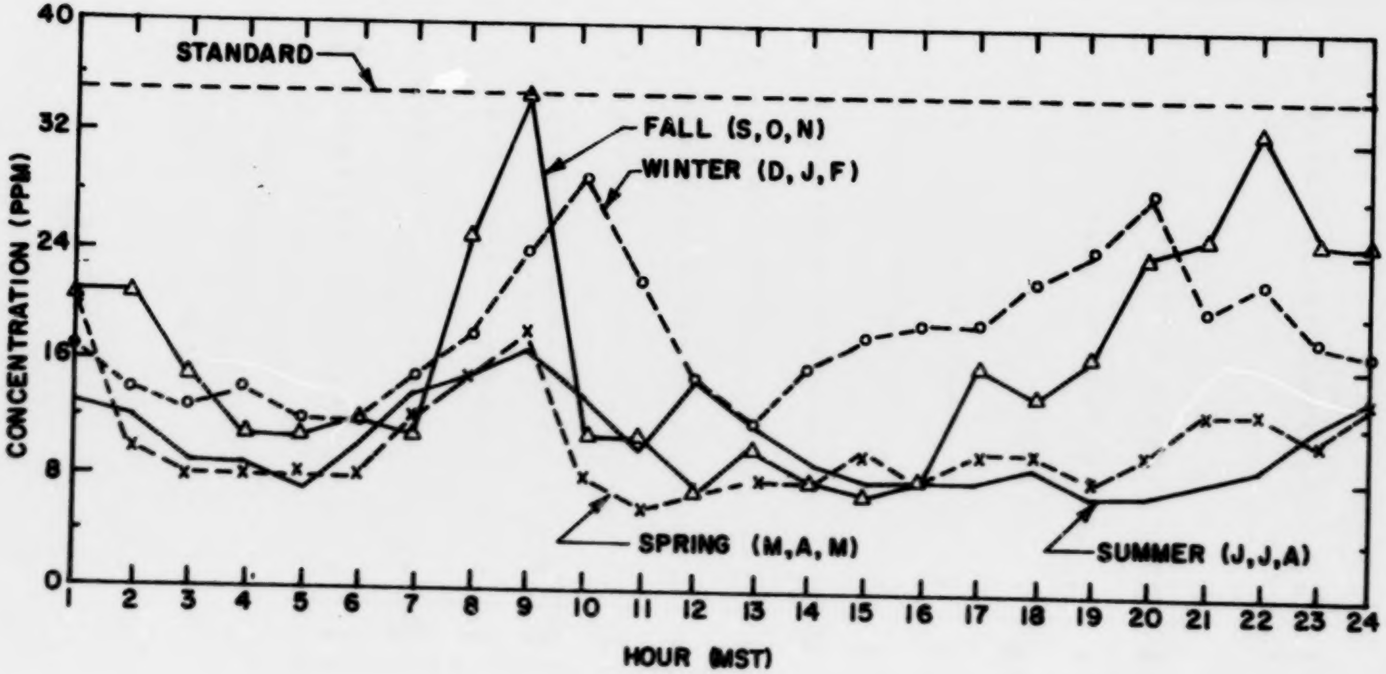


Figure II-2. Maximum 1-hour CO concentration observed each hour of the day in Salt Lake City by season.

# TABLE II-2

MAXIMUM 1-HOUR CO CONCENTRATIONS (IN PPM)

OBSERVED IN SALT LAKE CITY DURING THE PERIOD 1 JULY 1971 TO 30 JUNE 1972

| HOUR | JULY (1971) | AUG | SEPT | OCT | NOV | DEC | JAN (1972) | FEB | MAR | APR | MAY | JUNE | MAXIMUM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 13 | 12 | 16 | 17 | 21 | 17 | 10 | 12 | 20 | 9 | 10 | 9 | 21 |
| 2 | 12 | 12 | 13 | 14 | 21 | 14 | 12 | 11 | 10 | 8 | 7 | 8 | 21 |
| 3 | 9 | 8 | 10 | 9 | 15 | 13 | 13 | 11 | 8 | 8 | 7 | 9 | 15 |
| 4 | 8 | 8 | 7 | 7 | 11 | 14 | 12 | 12 | 6 | 8 | 6 | 9 | 14 |
| 5 | 6 | 5 | 3 | 6 | 11 | 12 | 9 | 11 | 4 | 8 | 6 | 7 | 12 |
| 6 | 6 | 10 | 3 | 5 | 12 | 11 | 11 | 12 | 4 | 8 | 7 | 7 | 12 |
| 7 | 8 | 14 | 4 | 8 | 11 | 12 | 11 | 13 | 7 | 8 | 12 | 8 | 15 |
| 8 | 15 | 15 | 17 | 25 | 25 | 13 | 17 | 18 | 15 | 10 | 7 | 10 | 25 |
| 9 | 13 | 17 | 23 | 35 | 35 | 18 | 24 | 17 | 18 | 8 | 7 | 10 | 35 |
| 10 | 10 | 14 | 8 | 11 | 11 | 29 | 15 | 17 | 6 | 8 | 6 | 9 | 29 |
| 11 | 7 | 10 | 6 | 8 | 11 | 22 | 12 | 8 | 5 | 4 | 6 | 10 | 22 |
| 12 | 7 | 15 | 3 | 7 | 6 | 15 | 11 | 7 | 4 | 7 | 6 | 10 | 15 |
| 13 | 7 | 12 | 3 | 7 | 10 | 12 | 9 | 6 | 4 | 8 | 5 | 9 | 12 |
| 14 | 7 | 9 | 5 | 7 | 8 | 16 | 8 | 10 | 4 | 8 | 6 | 9 | 16 |
| 15 | 8 | 8 | 5 | 7 | 7 | 18 | 7 | 11 | 4 | 10 | 7 | 5 | 18 |
| 16 | 8 | 6 | 8 | 7 | 8 | 19 | 10 | 13 | 4 | 7 | 8 | 5 | 19 |
| 17 | 8 | 8 | 16 | 7 | 9 | 19 | 15 | 13 | 4 | 8 | 10 | 5 | 19 |
| 18 | 9 | 7 | 14 | 7 | 14 | 22 | 12 | 15 | 6 | 7 | 10 | 5 | 22 |
| 19 | 7 | 6 | 8 | 7 | 17 | 24 | 12 | 17 | 7 | 8 | 8 | 5 | 24 |
| 20 | 7 | 6 | 10 | 13 | 24 | 28 | 12 | 13 | 8 | 10 | 7 | 5 | 28 |
| 21 | 8 | 8 | 8 | 13 | 25 | 20 | 12 | 13 | 11 | 13 | 8 | 5 | 25 |
| 22 | 8 | 9 | 9 | 14 | 33 | 22 | 14 | 17 | 10 | 13 | 10 | 5 | 33 |
| 23 | 12 | 10 | 13 | 20 | 25 | 18 | 10 | 12 | 11 | 11 | 10 | 5 | 25 |
| 24 | 13 | 16 | 17 | 18 | 25 | 17 | 10 | 13 | 14 | 12 | 7 | 9 | 25 |
| MAXIMUM | 15 | 17 | 23 | 35 | 35 | 29 | 24 | 18 | 20 | 13 | 12 | 10 | 35 |
| % POS. OBS. | 99 | 98 | 100 | 95 | 83 | 89 | 99 | 81 | 87 | 80 | 68 | 54 | |

## TABLE II-3

MAXIMUM 8-HOUR CO CONCENTRATION* (IN PPM) OBSERVED IN SALT LAKE CITY DURING THE PERIOD 1 JULY 1971 TO 30 JUNE 1972. NUMBERS IN PARENTHESES ARE NUMBER OF ADDITIONAL OBSERVATIONS GREATER THAN STANDARD (9 ppm). ENTRY IS AT HOUR ENDING 8-HOUR PERIOD

| HOUR | JULY (1971) | AUG | SEPT | OCT | NOV | DEC | JAN (1972) | FEB | MAR | APR | MAY | JUNE | MAX | NO. OVER STANDARD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8.8 | 6.9 | 7.9 | 12.1(2) | 21.9(8) | 15.0(1) | 10.4(1) | 12.4 | 9.6 | 9.0 | 5.6 | 8.5 | 21.9 | 18 |
| 2 | 8.6 | 7.8 | 9.3 | 13.1(2) | 23.5(7) | 14.8(1) | 10.4(1) | 12.3 | 9.9 | 9.9 | 5.6 | 8.3 | 23.5 | 19 |
| 3 | 9.1 | 7.9 | 10.3(1) | 13.1(2) | 23.3(7) | 14.1(1) | 10.9(1) | 12.0 | 10.6 | 10.5 | 5.6 | 8.4 | 23.3 | 21 |
| 4 | 9.6 | 7.8 | 10.4(1) | 12.6(1) | 21.6(7) | 14.1 | 11.1 | 12.0 | 10.4 | 10.3 | 5.8 | 8.6 | 21.6 | 18 |
| 5 | 9.8 | 7.5 | 9.9 | 11.9(1) | 19.9(3) | 14.0 | 10.8 | 11.8 | 9.9 | 9.6 | 6.0 | 8.5 | 19.9 | 13 |
| 6 | 9.4 | 7.1 | 9.1 | 10.4(1) | 17.3(1) | 13.9 | 10.4 | 11.6 | 9.4 | 9.0 | 5.8 | 8.1 | 17.3 | 10 |
| 7 | 9.0 | 7.0 | 8.5 | 9.0 | 15.5(1) | 13.8 | 10.5 | 12.0 | 8.8 | 8.6 | 5.5 | 7.9 | 15.5 | 5 |
| 8 | 8.9 | 7.9 | 7.3 | 8.1 | 15.0 | 13.3 | 11.5 | 12.8 | 8.9 | 8.4 | 5.4 | 8.3 | 15.0 | 4 |
| 9 | 8.5 | 8.3 | 6.3 | 10.9(3) | 14.0(2) | 12.9 | 13.6 | 13.4 | 8.6 | 8.3 | 5.0 | 8.5 | 14.0 | 10 |
| 10 | 8.8 | 8.8 | 6.3 | 11.3(3) | 12.4(2) | 12.9 | 14.0 | 14.1 | 8.4 | 8.3 | 5.1 | 8.6 | 14.1 | 10 |
| 11 | 8.5 | 9.3 | 6.1 | 11.6(3) | 11.5(2) | 11.1 | 13.0(1) | 13.8 | 7.8 | 7.5 | 5.1 | 8.8 | 13.8 | 12 |
| 12 | 8.4 | 10.4 | 6.0 | 11.5(3) | 11.4(2) | 12.5 | 12.0(1) | 12.5 | 7.3 | 6.9 | 5.4 | 8.9 | 12.5 | 12 |
| 13 | 8.4 | 11.3 | 6.0 | 11.3(3) | 11.4(2) | 13.5 | 11.9 | 11.4 | 7.0 | 6.1 | 5.5 | 9.1 | 13.5 | 12 |
| 14 | 8.4 | 11.8 | 6.1 | 11.1(3) | 11.3(1) | 14.4 | 11.5 | 10.3 | 6.6 | 5.4 | 5.6 | 9.4 | 14.4 | 11 |
| 15 | 8.1 | 12.0 | 5.9 | 11.0(3) | 10.8(1) | 14.8 | 10.6 | 8.8 | 6.0 | 4.9 | 5.6 | 9.0 | 14.8 | 9 |
| 16 | 7.4 | 11.4 | 4.6 | 8.8 | 8.5 | 14.8 | 9.5 | 8.1 | 4.3 | 4.5 | 5.6 | 8.4 | 14.8 | 3 |
| 17 | 7.5 | 9.9 | 4.9 | 5.1 | 7.8 | 13.9 | 7.5 | 7.6 | 4.0 | 4.5 | 5.4 | 7.8 | 13.9 | 2 |
| 18 | 7.6 | 8.9 | 6.5 | 4.9 | 7.3 | 12.3(1) | 8.4 | 8.0 | 4.0 | 6.0 | 5.3 | 7.3 | 12.3 | 2 |
| 19 | 7.6 | 8.3 | 7.4 | 4.8 | 7.5 | 11.6(2) | 8.4 | 9.0 | 4.3 | 7.6 | 7.1 | 6.6 | 11.6 | 3 |
| 20 | 7.6 | 7.1 | 8.5 | 7.1 | 9.8 | 14.4(2) | 8.9 | 10.3(1) | 4.8 | 7.9 | 7.6 | 6.0 | 14.4 | 6 |
| 21 | 7.8 | 6.5 | 9.3 | 7.3 | 12.1(2) | 17.4(2) | 9.6 | 11.6(1) | 5.0 | 7.6 | 8.0 | 5.5 | 17.4 | 10 |
| 22 | 7.9 | 6.6 | 9.8 | 7.6 | 15.6(4) | 16.9(2) | 9.8(1) | 13.0(1) | 5.3 | 7.3 | 8.5 | 5.8 | 16.9 | 13 |
| 23 | 8.4 | 7.0 | 9.9 | 8.6 | 18.1(6) | 16.8(2) | 9.9(2) | 12.1 | 6.1 | 7.0 | 8.9 | 5.0 | 18.1 | 15 |
| 24 | 8.8 | 6.9 | 9.8 | 10.5(2) | 20.1(6) | 16.5(2) | 10.4(2) | 12.3 | 6.0 | 6.0 | 8.8 | 5.0 | 20.1 | 18 |
| MAXIMUM | 9.8 | 12.0 | 10.4 | 13.1 | 23.5 | 17.4 | 14.0 | 14.1 | 10.4 | 10.5 | 8.9 | 9.4 | | |
| NO. OVER STD. | 4 | 7 | 11 | 46 | 84 | 40 | 30 | 22 | 6 | 4 | - | 2 | | 256 |
| % PER. OBS. | 97 | 96 | 100 | 87 | 79 | 85 | 96 | 75 | 82 | 78 | 81 | 52 | | |

---

*Tabular values are based on a running mean of 8 one-hour averages.

## TABLE II-4

## HIGHEST TOTAL OXIDANT LEVELS OBSERVED AT SALT LAKE CITY

| Sampling Period | 1-Hr Concentration (ppm) | |
|---|---|---|
| | Highest | 2nd Highest* |
| Jan 1970 - Dec 1970 (Used in Implementation Plan) | 0.11 | 0.11 |
| July 1971 - June 1972 (Latest 1-yr data set) | 0.093 | 0.093 |

*Values are to be compared with the national standard of 0.08 ppm, which is not to be exceeded more than once a year.

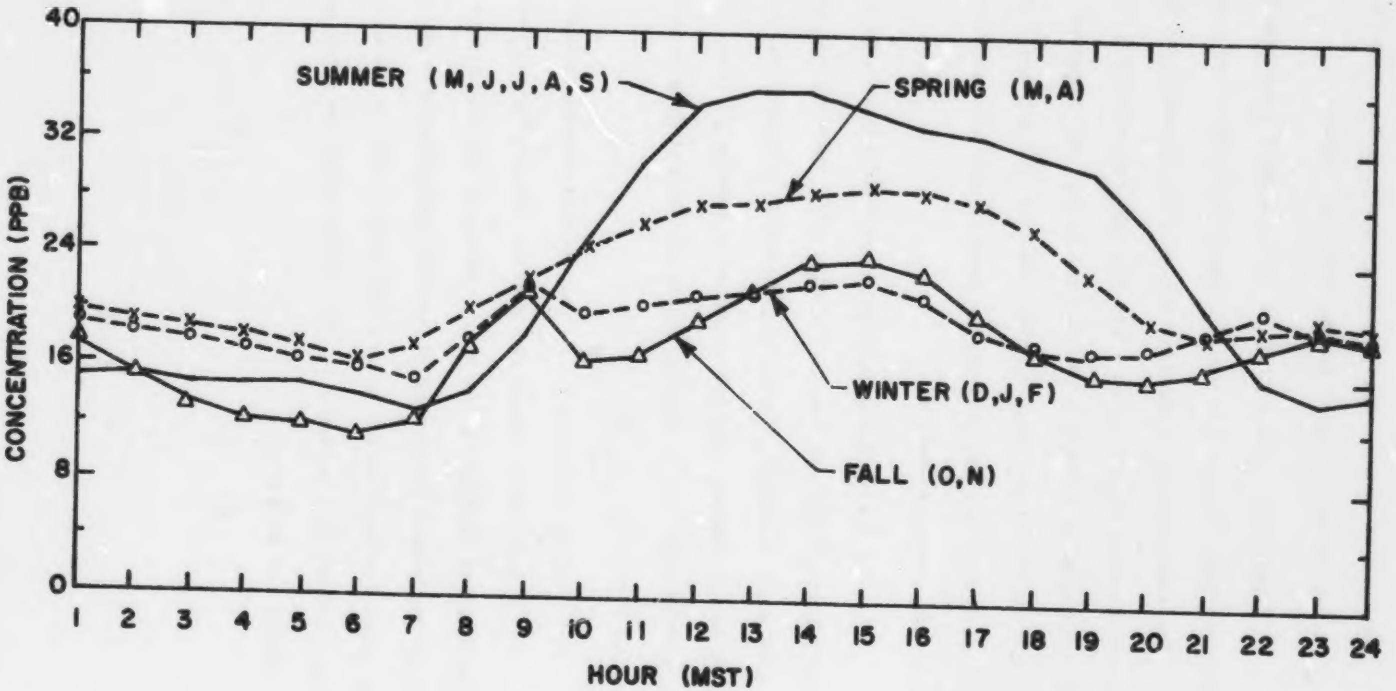


Figure II-3. Diurnal variation of average oxidant concentrations in Salt Lake City by season.

seasons. The highest concentration occurs shortly after noon in summer and about one or two hours later in the fall and winter.

Figure II-4 is a plot of the maximum 1-hour concentration which occurred each hour of the day for each of the modified seasonal periods. The summer curve of maximum values closely parallels the summer average curve of Figure II-3, and the national standard is slightly exceeded from 1100 to 1700 MST. Rather curiously, the standard is also exceeded during the winter both at 0900 and 1000 MST and again at 2200 MST. The fall curve also has maximums in the morning and late evening, in addition to an afternoon maximum.

Table II-5 gives the maximum 1-hour concentration observed during each hour of the day for each month. The standard was exceeded on one or more days in August, September, December, January, May and June with 11 of the 21 values over the standard occurring in June. With one exception (2200 MST) all values in excess of the standard occurred between 0900 and 1700 MST.

### d. Monthly Variation of CO and Oxidant Concentrations

Figure II-5 shows the average monthly concentration of CO and total oxidant throughout the year. Although the curves are quite irregular, the yearly pattern of minimum CO concentrations and maximum oxidant concentrations in the spring and summer, and of maximum CO concentration and minimum oxidants in the winter which was discussed earlier in the report can be seen.

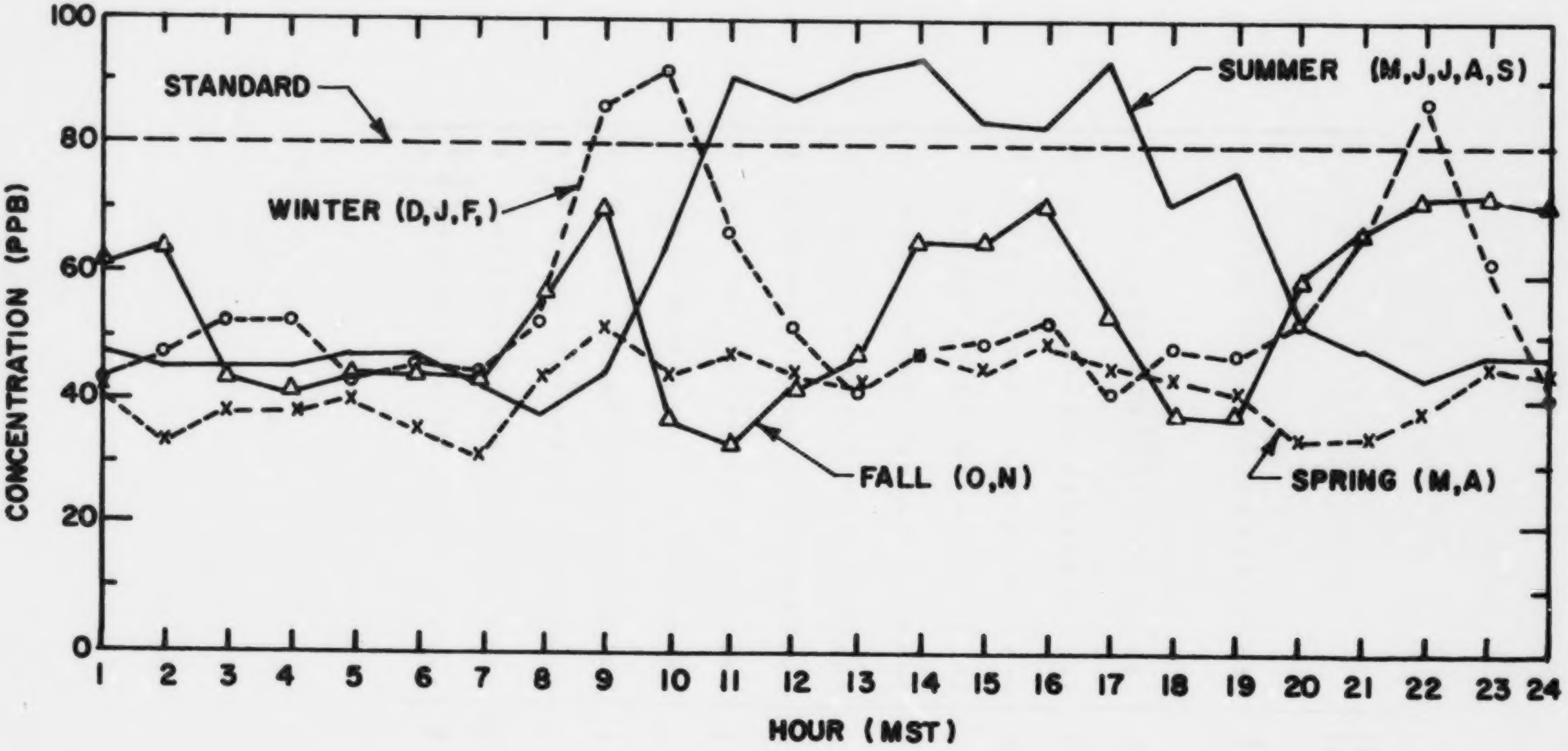


Figure II-4. Maximum 1-hour oxidant concentration observed each hour of the day in Salt Lake City by season.

## TABLE II-5

MAXIMUM 1-HOUR OXIDANT CONCENTRATIONS (IN PPB) OBSERVED IN SALT LAKE CITY DURING THE PERIOD 1 JULY 1971 TO 30 JUNE 1972. NUMBERS IN PARENTHESES ARE NUMBER OF ADDITIONAL OBSERVATIONS GREATER THAN STANDARD (80 PPB).

| HOUR | JULY 1971 | AUG | SEPT | OCT | NOV | DEC | JAN 1972 | FEB | MAR | APR | MAY | JUNE | MAXIMUM | NO. OVER STANDARD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 22 | 30 | 33 | 36 | 61 | 40 | 31 | 63 | 41 | 35 | 44 | 47 | 63 | |
| 2 | 20 | 22 | 41 | 26 | 63 | 35 | 47 | 38 | 33 | 31 | 45 | 42 | 63 | |
| 3 | 23 | 24 | 41 | 24 | 43 | 37 | 52 | 37 | 27 | 38 | 45 | 41 | 52 | |
| 4 | 26 | 24 | 41 | 23 | 41 | 40 | 52 | 38 | 29 | 38 | 45 | 38 | 52 | |
| 5 | 20 | 23 | 38 | 23 | 44 | 40 | 43 | 41 | 33 | 40 | 47 | 44 | 47 | |
| 6 | 19 | 26 | 38 | 21 | 44 | 36 | 45 | 40 | 28 | 35 | 45 | 47 | 47 | |
| 7 | 15 | 17 | 31 | 19 | 43 | 36 | 44 | 35 | 28 | 31 | 42 | 42 | 44 | |
| 8 | 14 | 14 | 29 | 33 | 55 | 41 | 52 | 37 | 43 | 28 | 38 | 36 | 55 | |
| 9 | 16 | 21 | 46 | 34 | 70 | 56 | 87 | 45 | 51 | 36 | 38 | 35 | 87 | 1 |
| 10 | 36 | 38 | 42 | 37 | 37 | 92 | 29 | 48 | 30 | 44 | 47 | 66 | 92 | 1 |
| 11 | 33 | 58 | 41 | 26 | 33 | 66 | 38 | 35 | 35 | 47 | 66 | 90(2) | 90 | 3 |
| 12 | 52 | 66 | 54 | 33 | 42 | 51 | 37 | 31 | 35 | 44 | 70 | 87(1) | 87 | 2 |
| 13 | 66 | 85(1) | 68 | 47 | 41 | 41 | 25 | 38 | 35 | 43 | 72 | 91(2) | 91 | 5 |
| 14 | 63 | 93 | 71 | 65 | 55 | 36 | 35 | 47 | 37 | 47 | 85 | 87(1) | 93 | 4 |
| 15 | 31 | 70 | 82 | 52 | 65 | 35 | 37 | 49 | 36 | 45 | 76 | 86 | 86 | 2 |
| 16 | 47 | 61 | 83 | 71 | 57 | 31 | 52 | 36 | 35 | 49 | 33 | 77 | 83 | 1 |
| 17 | 66 | 38 | 93 | 34 | 41 | 36 | 41 | 37 | 35 | 45 | 55 | [illegible] | 93 | 1 |
| 18 | 66 | 62 | 70 | 38 | 26 | 48 | 29 | 27 | 33 | 43 | 56 | 66 | 70 | |
| 19 | 36 | 39 | 76 | 29 | 37 | 47 | 28 | 29 | 29 | 41 | 56 | 58 | 76 | |
| 20 | 33 | [illegible] | 41 | 21 | 59 | 52 | 38 | 29 | 27 | 36 | 51 | 52 | 59 | |
| 21 | 47 | 31 | 29 | 20 | 66 | 66 | 43 | 37 | 36 | 31 | 49 | 42 | 66 | |
| 22 | 66 | 30 | 27 | 27 | 72 | 86 | 50 | 37 | 38 | 31 | 35 | 33 | 86 | 1 |
| 23 | 26 | 30 | 23 | 33 | 72 | 61 | 35 | 48 | 43 | 36 | 47 | 38 | 72 | |
| 24 | 21 | 35 | 23 | 30 | 71 | 40 | 35 | 43 | 44 | 36 | 37 | 67 | 71 | |
| MAXIMUM | 66 | 93 | 93 | 71 | 72 | 92 | 87 | 63 | 51 | 49 | 85 | 91 | | |
| NO. OVER STD. | | 3 | 3 | | | 2 | 1 | | | | 1 | 11 | | 21 |
| % POS. OBS. | 90 | 99 | 99 | 99 | 100 | 100 | 89 | 97 | 89 | [illegible] | [illegible] | 96 | | |

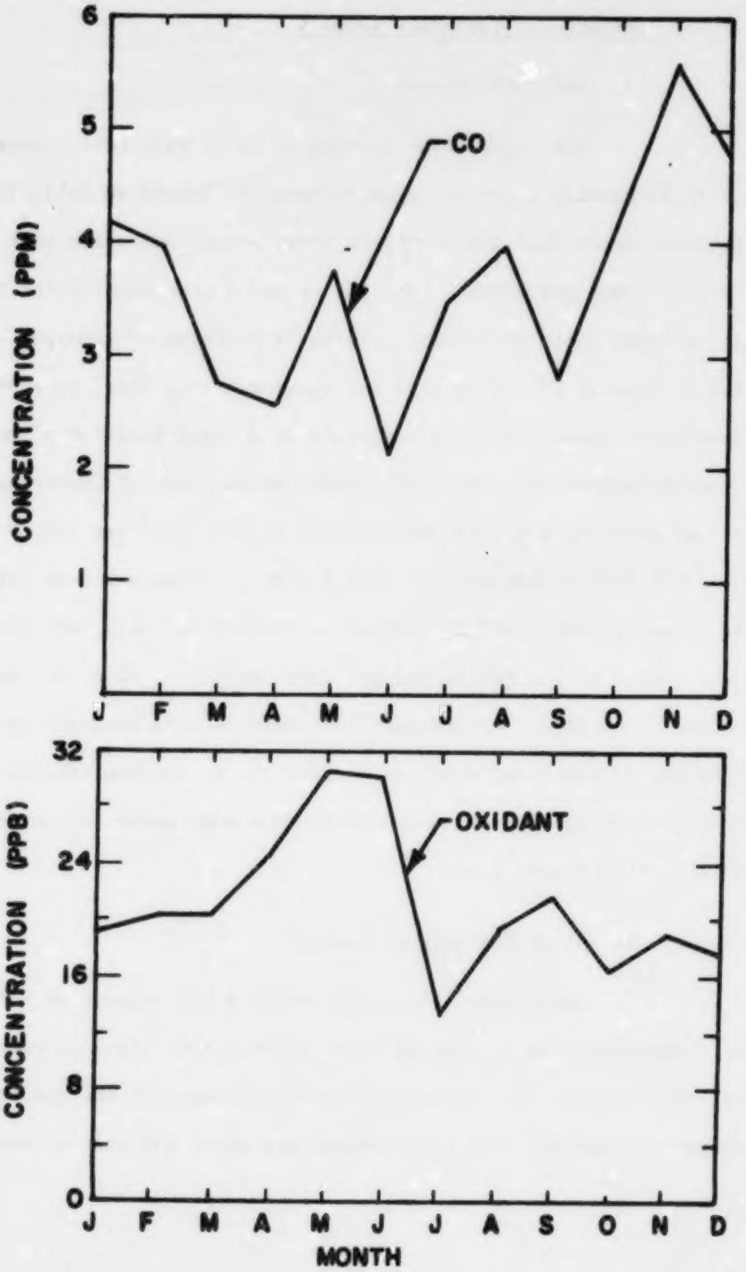


Figure II-5. Monthly variations in CO and oxidant concentrations in Salt Lake City.

## 4. Impact of Stationary Sources

### a. Major CO Sources

The major point sources of CO in Salt Lake County, arranged in descending order of emission rate are listed in Table II-6 Table II-B-6 shows that the strongest point source emits 225 tons per year or 6.5 grams per second. The use of any conventional point source diffusion model (see, for example, Turner's Workbook of Atmospheric Dispersion Estimates) will show that the maximum ground level concentration expected from a source of this magnitude is a small fraction of the allowable concentration even under unfavorable meteorological conditions. As an extreme example, a ground-level source of 6.5 grams per second under class F stability conditions and with a wind speed of 2 meters per second yields a peak ground level concentration (10-min average) one kilometer from the source of 2.3 milligrams per cubic meter, or about six percent of the one-hour standard. Accordingly,as a sufficiently accurate approximation for the proportional modeling carried out in Section IID, CO emissions other than those from vehicular traffic are considered uniform throughout the critical area.

### b. Major Hydrocarbon Sources

Table II-7 lists the major point sources of hydrocarbons in Salt Lake County in descending order of emission rate. In part because of the complexity of the chemical reactions involved in the generation of photochemical oxidants from hydrocarbons and other pollutants, there exists

## TABLE II-6

### MAJOR POINT SOURCES OF CO EMISSIONS
### SALT LAKE COUNTY
### 1970

| Company | Location | Emissions (Tons/year) |
|---|---|---|
| May Foundry | 454 W. 5th North St., SLC | 225 |
| Kennecott | NW of Magna | 87 |
| Welfare Square | 751 W. 7th South St., SLC | 49 |
| American Oil Co. | 474 W. 8th North St., SLC | 37 |
| Kaibab Lumber | 375 No. Main St., Midvale | 33 |
| Granite Mill & Fixture | 400 W. 300 North St., SLC | 31 |
| Murray City Power | 148 W. 4800 South St., Murray | 27 |
| Pippy Foundry | 455 No. 4th West St., SLC | 16 |

## TABLE II-7

## MAJOR POINT SOURCES OF HC EMISSIONS
## SALT LAKE COUNTY
## 1970

| Company | Location | Emissions<br>(Tons/year) |
|---|---|---|
| American Oil Co. | 474 W. 8th North St., SLC | 8416 |
| Kennecott | West of Magna | 497 |
| Utah Power & Light | 1407 W. North Temple, SLC | 235 |
| Murray City Power | 148 W. 4800 South St., Murray | 164 |
| Portland Cement | 615 W. 8th South St., SLC | 33 |
| Little America | 1200 Beck St., SLC | 26 |
| University of Utah | NE of 13th East & 5th So., SLC | 22 |
| Interstate Brick | 3100 So. 11th East St., SLC | 10 |
| Stauffer Chemical | SE of Magna | 10 |
| Welfare Square | 751 W. 7th South St., SLC | 10 |

no suitable model to relate source emissions spatially to the resulting oxidant levels in the Salt Lake City area. For the proportional modeling carried out in Section IID, hydrocarbon emissions from non-vehicular sources are considered uniform through the critical area.

### 5. Required Air Quality Improvement

#### a. Improvement Dictated by 1970 Observations

#### CO Levels

In the Implementation Plan, a proportional model was used to determine the percent reduction in CO emissions that would be required to meet the national standards. It was assumed that the background concentration of CO was zero and that the appropriate concentration for use in the rollback calculation was the second highest concentration observed in 1970.

The rollback calculations were as follows:

1-hour average

$$\frac{37-35}{37} = 5\% \text{ reduction needed to attain standard}$$

8-hour average

$$\frac{22-9}{22} = 59\% \text{ reduction needed to attain standard}$$

where 37 and 22 are the second highest observed 1-hour and 8-hour concentrations in ppm respectively, and the corresponding standards are 35 ppm and 9 ppm.

### Oxidant Levels

The curve shown in Figure 1 of Appendix J of 40 CFR, Part 51 was used with the second highest 1-hour average concentration of photochemical oxidants to give the reduction in hydrocarbon emissions required to achieve the national standards.

The use of the second highest 1-hour concentration (0.11 ppm) and Figure 1, Appendix J of 40 CFR, Part 51, yields a required reduction in hydrocarbon emissions of 25 percent.

### b. Improvement Dictated by 1971-1972 Observations

### CO Levels

Table II-1 shows that no 1-hour CO concentration exceeded the standard during the period July 1971 - June 1972. The use of the second-highest, 8-hour concentration observed during this period gives a required reduction of 47 percent. The calculation is as follows:

$$\frac{17-9}{17} = 47\% \text{ reduction needed to attain standard}$$

where 17 is the second highest observed 8-hour concentration in ppm, and the 8-hour standard is 9 ppm.

### Oxidant Levels

Table II-4 shows that the second-highest, 1-hour concentration of total oxidants observed during the July 1971-June 1972 period was 0.093 ppm. The use of this value with Appendix J of 40 CFR, Part 51 gives a required reduction in hydrocarbon emissions of about 11 percent.

## C. DISCUSSION OF VEHICLE MILES OF TRAVEL

### 1. General

The geographical limits established for the purpose of this study include all of the area within the city limits of Salt Lake City and areas within the County which lie south of the city limits. The total area covers approximately 110 square miles. The northeast and west boundaries are approximately coincident with existing city limit lines and the south boundary extends to 7800 South Street.

For the purpose of computing current and projected vehicle miles traveled, the study area was broken down into 239 zones. The downtown or core area, particularly around the existing pollution sensor, was broken down into zones which contain approximately four square blocks and ranged in size from .07 to .10 square miles. Outside the core area where traffic congestion is not so severe, and the travel per square mile is less, the zones were increased in size to approximately one square mile (see Figure II-6.)

The first step in analyzing the daily vehicle miles traveled was to assemble all available information on the latest average daily traffic counts made within the study area (see Figure II-7). This information was obtained from several sources -- Salt Lake City Traffic Engineering Department, Salt Lake County, and the Utah State Department of Highways. On certain streets where traffic counts were not available, estimates of daily traffic were made based upon location and type of street, and actual counts made on similar streets in the area. The

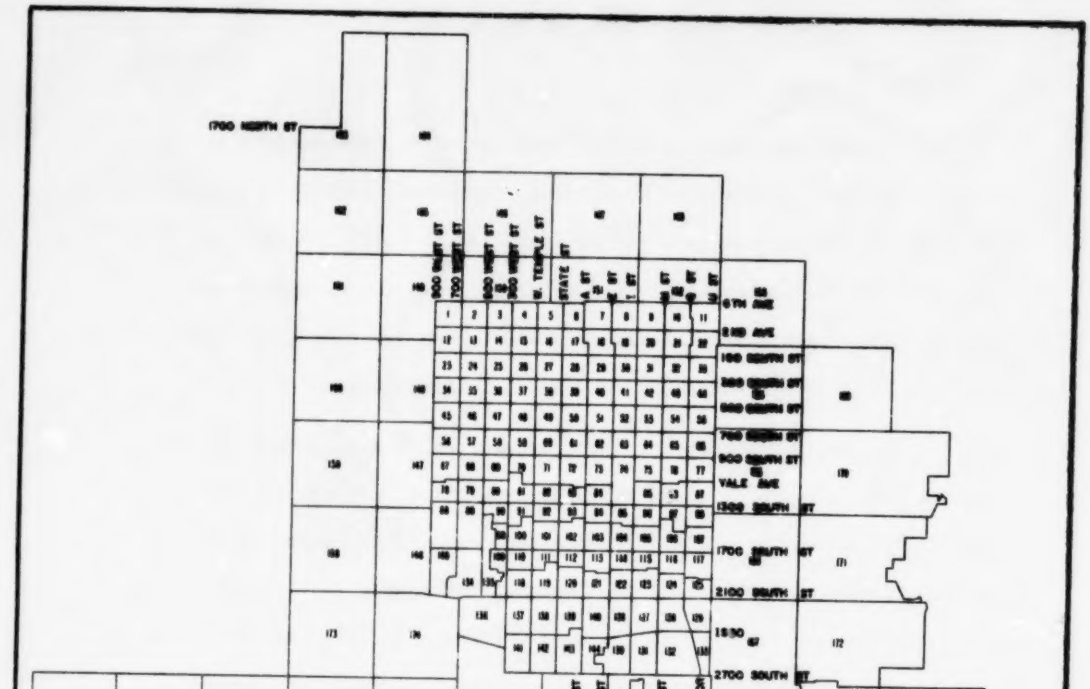

1700 NORTH ST
300 WEST ST
600 WEST ST
W. TEMPLE ST
STATE ST
6TH AVE
3RD AVE
100 SOUTH ST
300 SOUTH ST
500 SOUTH ST
700 SOUTH ST
900 SOUTH ST
VALE AVE
1300 SOUTH ST
1700 SOUTH ST
2100 SOUTH ST
2700 SOUTH ST
300 EAST ST
500 EAST ST
900 EAST ST
HIGHLAND DR
EVERGREEN AVE
4100 SOUTH ST
4800 WEST ST
4000 WEST ST
3200 WEST ST
2200 WEST ST
1300 WEST ST
700 WEST ST
MAIN ST
700 EAST ST
1300 EAST ST
2000 EAST ST
2700 EAST ST
3500 EAST ST
4700 SOUTH ST
5400 SOUTH ST
6200 SOUTH ST
7000 SOUTH ST
7800 SOUTH ST
ZONE NUMBER
ZONE BOUNDARY
NORTH
0
4000
8000
10,000
FEET

**Figure II-6. Traffic Zones Salt Lake City.**

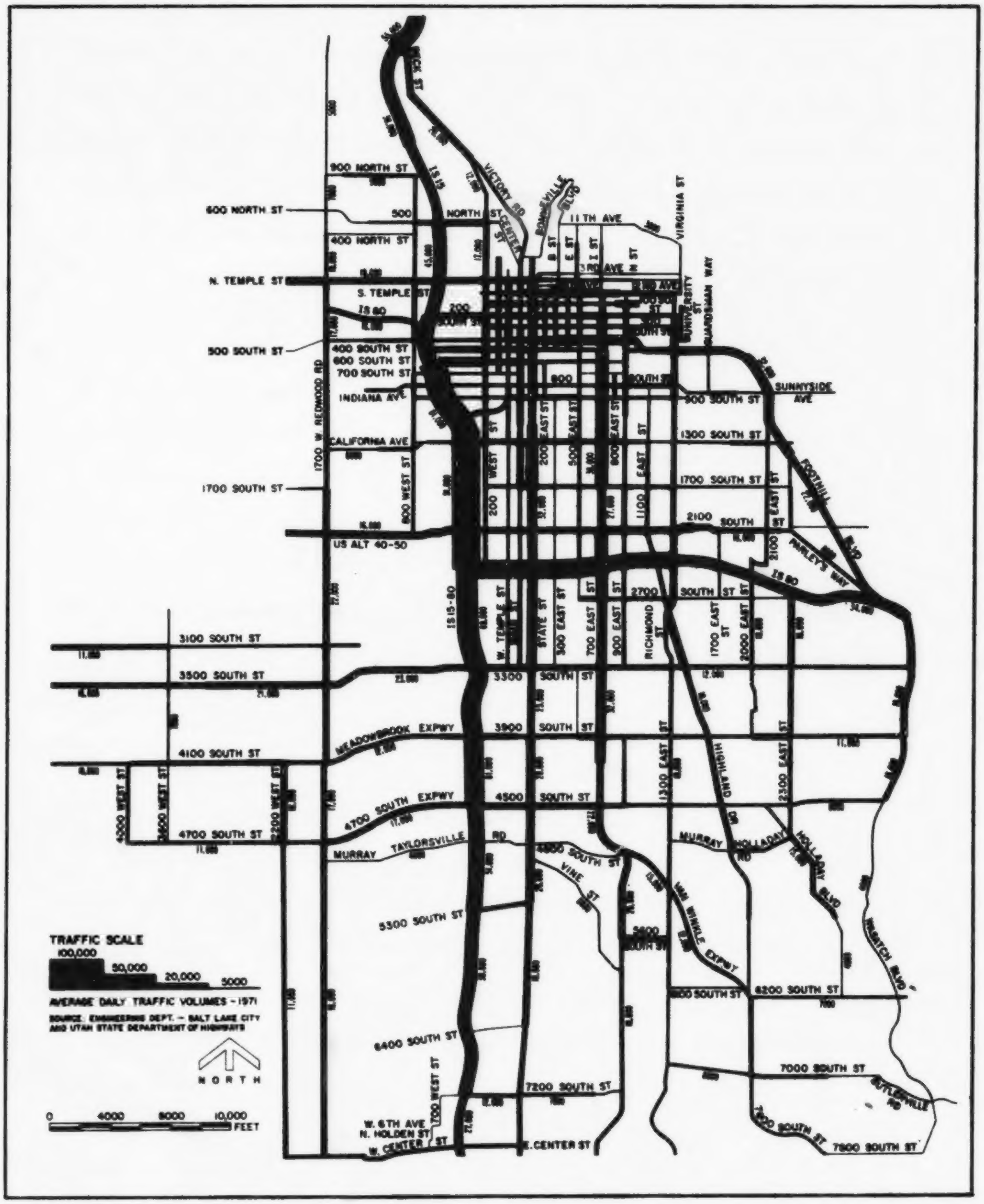

TRAFFIC SCALE
100,000
50,000
20,000
5000
AVERAGE DAILY TRAFFIC VOLUMES - 1971
SOURCE: ENGINEERING DEPT. - SALT LAKE CITY AND UTAH STATE DEPARTMENT OF HIGHWAYS
NORTH
0
4000
8000
10,000
FEET
900 NORTH ST
600 NORTH ST
500 NORTH ST
400 NORTH ST
N. TEMPLE ST
S. TEMPLE ST
IS 80
200 SOUTH ST
500 SOUTH ST
400 SOUTH ST
600 SOUTH ST
700 SOUTH ST
INDIANA AVE
CALIFORNIA AVE
1700 SOUTH ST
1700 W. REDWOOD RD
800 WEST ST
US ALT 40-50
IS 15
IS15-80
VICTORY RD
BECK ST
CENTER ST
BONNEVILLE BLVD
11 TH AVE
VIRGINIA ST
B ST
E ST
I ST
N ST
3RD AVE
UNIVERSITY ST
GUARDSMAN WAY
SUNNYSIDE AVE
900 SOUTH ST
1300 SOUTH ST
1700 SOUTH ST
2100 SOUTH ST
2100 EAST ST
FOOTHILL BLVD
PARLEY'S WAY
IS 80
200 WEST ST
200 EAST ST
500 EAST ST
600 EAST ST
1100 EAST ST
2700 SOUTH ST
W. TEMPLE ST
STATE ST
300 EAST ST
700 EAST ST
900 EAST ST
RICHMOND ST
1700 EAST ST
2000 EAST ST
3100 SOUTH ST
3500 SOUTH ST
3300 SOUTH ST
3900 SOUTH ST
MEADOWBROOK EXPWY
4100 SOUTH ST
4000 WEST ST
3600 WEST ST
2200 WEST ST
4700 SOUTH ST
4700 SOUTH EXPWY
4500 SOUTH ST
1300 EAST ST
HIGHLAND DR
2300 EAST ST
MURRAY TAYLORSVILLE RD
4800 SOUTH ST
VINE ST
MURRAY HOLLADAY RD
HOLLADAY BLVD
VAN WINKLE EXPWY
5300 SOUTH ST
5600 SOUTH ST
WASATCH BLVD
6100 SOUTH ST
6200 SOUTH ST
6400 SOUTH ST
7000 SOUTH ST
COTTONWOOD RD
7200 SOUTH ST
700 WEST ST
W. 6TH AVE
N. HOLDEN ST
W. CENTER ST
E. CENTER ST
7800 SOUTH ST

Figure II-7. Traffic volumes - 1971; Salt Lake City.

most recent available counts were made in 1971. By using the length of the streets and/or freeways within a particular sub-area or zone and the average daily traffic on those streets, the daily vehicle miles traveled were calculated. An expansion factor, provided by the Utah State Department of Highways, was then applied to the 1971 daily VMT to estimate 1977 daily VMT. The 1971 VMT by zones, the expansion factors and the 1977 VMT are all shown in Appendix A.

### 2. Traffic Densities

In order to develop a basis for determining alternatives for reducing the vehicle concentrations, it was necessary to determine the areas of greatest vehicle concentrations during given time periods. Appendix B shows the area in square miles of each zone, the 1971 and 1977 VMT, and the vehicle miles traveled per square mile for both streets and freeways. It can be readily seen that the greatest densities exist in the central business district where the available street capacities are relatively fixed.

### 3. Traffic Variations

In addition to daily volumes, knowledge of traffic variations by time of day is important in determining vehicular emissions. Hourly traffic variations by type of vehicle for the Salt Lake area are shown in Table II-8. This information was obtained from the Salt Lake Area Transportation Study and was checked against more recent counts on specific streets. Since the data provided in the Salt Lake Area Trans-

## TABLE II-8

## HOURLY TRAFFIC VARIATIONS

| HOUR | TRUCKS* | | TOTAL VEHICLES | | PERCENT TRUCKS |
|---|---|---|---|---|---|
| | No. | Pct.of 24-Hr. | No. | Pct.of 24-Hr. | |
| A.M. | | | | | |
| 0-1 | 204 | 0.6 | 2,669 | 1.2 | 7.6 |
| 1-2 | 149 | 0.5 | 1,341 | .6 | 11.1 |
| 2-3 | 114 | 0.3 | 661 | .3 | 17.2 |
| 3-4 | 128 | 0.4 | 580 | .3 | 22.0 |
| 4-5 | 199 | 0.6 | 743 | .3 | 26.7 |
| 5-6 | 298 | 0.9 | 1,623 | .7 | 18.3 |
| 6-7 | 1,015 | 3.1 | 5,529 | 2.5 | 18.3 |
| 7-8 | 2,563 | 7.8 | 18,619 | 8.4 | 13.7 |
| 8-9 | 2,508 | 7.7 | 14,115 | 6.4 | 17.7 |
| 9-10 | 2,353 | 7.2 | 10,486 | 4.7 | 22.4 |
| 10-11 | 2,337 | 7.1 | 10,714 | 4.8 | 21.8 |
| 11-12 | 2,203 | 6.7 | 11,219 | 5.1 | 19.6 |
| P.M. | | | | | |
| 12-1 | 1,964 | 6.0 | 11,348 | 5.1 | 17.3 |
| 1-2 | 2,069 | 6.3 | 11,298 | 5.1 | 18.3 |
| 2-3 | 2,361 | 7.2 | 12,112 | 5.5 | 19.4 |
| 3-4 | 2,642 | 8.1 | 14,431 | 6.5 | 18.3 |
| 4-5 | 3,134 | 9.6 | 20,294 | 9.1 | 15.4 |
| 5-6 | 2,473 | 7.6 | 20,781 | 9.4 | 11.9 |
| 6-7 | 1,420 | 4.3 | 14,151 | 6.4 | 10.0 |
| 7-8 | 873 | 2.7 | 11,344 | 5.1 | 7.6 |
| 8-9 | 593 | 1.8 | 8,852 | 4.0 | 6.7 |
| 9-10 | 442 | 1.4 | 7,972 | 3.6 | 5.5 |
| 10-11 | 389 | 1.2 | 6,403 | 2.9 | 6.1 |
| 11-12 | 292 | 0.9 | 4,526 | 2.0 | 6.5 |
| Total | 32,723 | 100.0 | 221,811 | 100.0 | 14.8 |

---

* Includes panel and pickup.

Source: Salt Lake Area Transportation Study, Volume 1.

portation Study are more comprehensive (they cover local and arterial streets) they were used as a base for estimating traffic variations in Salt Lake City.

### 4. Vehicle Type

The composition of traffic is another important characteriistic which was determined; basically, the composition of traffic varies according to the type of street. This was verified for Salt Lake using information contained in the Salt Lake Transportation Study plus current traffic classification counts provided by the Utah Department of Highways. Using these sources of information, estimates of travel by heavy-duty trucks (greater than 6000 lbs.) were developed for three areas:

- Core area
- Freeways
- Total study area.

These estimates are shown in Tables II-9, II-10, and II-11. Note that the percentage of trucks (heavy-duty) is highest on freeways (4.8 percent daily) and lowest on the streets (non-freeway) in the core area (1.7 percent daily).

### 5. Trip Purpose

The Salt Lake Area Transportation Study and the Transit Improvement Program prepared for the Utah Transit Authority contain basic information on trip purpose for the study area. Table II-12 taken from the Salt Lake Area Transportation Study presents daily auto driver and

## TABLE II-9

## ESTIMATED TRAFFIC VARIATIONS
(Core Area)

| HOUR | TOTAL TRAFFIC AS PERCENT OF 24-HOUR (ADT) | HEAVY DUTY VEHICLES AS PERCENT OF TOTAL TRAFFIC (ADT) |
|---|---|---|
| A.M. | | |
| 0-1 | 1.2 | 0.9 |
| 1-2 | .6 | 1.3 |
| 2-3 | .3 | 2.0 |
| 3-4 | .3 | 2.5 |
| 4-5 | .3 | 3.1 |
| 5-6 | .7 | 2.1 |
| 6-7 | 2.5 | 2.1 |
| 7-8 | 8.4 | 1.6 |
| 8-9 | 6.4 | 2.0 |
| 9-10 | 4.7 | 2.6 |
| 10-11 | 4.8 | 2.5 |
| 11-12 | 5.1 | 2.3 |
| P.M. | | |
| 12-1 | 5.1 | 2.0 |
| 1-2 | 5.1 | 2.1 |
| 2-3 | 5.5 | 2.2 |
| 3-4 | 6.5 | 2.1 |
| 4-5 | 9.1 | 1.8 |
| 5-6 | 9.4 | 1.4 |
| 6-7 | 6.4 | 1.1 |
| 7-8 | 5.1 | 0.9 |
| 8-9 | 4.0 | 0.8 |
| 9-10 | 3.6 | 0.6 |
| 10-11 | 2.9 | 0.7 |
| 11-12 | 2.0 | 0.7 |
| TOTAL | 100.0 | AVERAGE 1.7 |

## TABLE II-10

## ESTIMATED TRAFFIC VARIATIONS
(Freeway)

| HOUR | TOTAL TRAFFIC AS PERCENT OF 24-HOUR (ADT) | HEAVY DUTY VEHICLES AS PERCENT OF TOTAL TRAFFIC (ADT) |
|---|---|---|
| **A.M.** | | |
| 0-1 | 1.2 | 2.5 |
| 1-2 | .6 | 3.6 |
| 2-3 | .3 | 5.6 |
| 3-4 | .3 | 7.2 |
| 4-5 | .3 | 8.7 |
| 5-6 | .7 | 6.0 |
| 6-7 | 2.5 | 6.0 |
| 7-8 | 8.4 | 4.5 |
| 8-9 | 6.4 | 5.8 |
| 9-10 | 4.7 | 7.2 |
| 10-11 | 4.8 | 7.1 |
| 11-12 | 5.1 | 6.4 |
| **P.M.** | | |
| 12-1 | 5.1 | 5.6 |
| 1-2 | 5.1 | 6.0 |
| 2-3 | 5.5 | 6.3 |
| 3-4 | 6.5 | 6.0 |
| 4-5 | 9.1 | 5.0 |
| 5-6 | 9.4 | 3.9 |
| 6-7 | 6.4 | 3.2 |
| 7-8 | 5.1 | 2.5 |
| 8-9 | 4.0 | 2.2 |
| 9-10 | 3.6 | 1.8 |
| 10-11 | 2.9 | 2.0 |
| 11-12 | 2.0 | 2.1 |
| TOTAL | 100.0 | AVERAGE 4.8 |

## TABLE II-11

## ESTIMATED TRAFFIC VARIATIONS
(Total Study Area)

| HOUR | TOTAL TRAFFIC AS PERCENT OF 24-HOUR (ADT) | HEAVY DUTY VEHICLES AS PERCENT OF TOTAL TRAFFIC (ADT) |
|---|---|---|
| **A.M.** | | |
| 0-1 | 1.2 | 1.7 |
| 1-2 | .6 | 2.4 |
| 2-3 | .3 | 3.8 |
| 3-4 | .3 | 4.8 |
| 4-5 | .3 | 5.9 |
| 5-6 | .7 | 4.0 |
| 6-7 | 2.5 | 4.0 |
| 7-8 | 8.4 | 3.0 |
| 8-9 | 6.4 | 3.9 |
| 9-10 | 4.7 | 4.9 |
| 10-11 | 4.8 | 4.8 |
| 11-12 | 5.1 | 4.3 |
| **P.M.** | | |
| 12-1 | 5.1 | 3.8 |
| 1-2 | 5.1 | 4.0 |
| 2-3 | 5.5 | 4.3 |
| 3-4 | 6.5 | 4.0 |
| 4-5 | 9.1 | 3.4 |
| 5-6 | 9.4 | 2.6 |
| 6-7 | 6.4 | 2.2 |
| 7-8 | 5.1 | 1.7 |
| 8-9 | 4.0 | 1.5 |
| 9-10 | 3.6 | 1.2 |
| 10-11 | 2.9 | 1.3 |
| 11-12 | 2.0 | 1.4 |
| TOTAL | 100.0 | AVERAGE 3.25 |

## TABLE II-12

## AUTO TRIPS BY PURPOSE INTERNAL SURVEY - 1960

| TRIP PURPOSE | VEHICULAR | PER CENT OF TOTAL |
|---|---|---|
| AUTO DRIVER | | |
| Work | 137,162 | 22.0 |
| Personal Business | 23,590 | 3.8 |
| Medical-Dental | 4,855 | 0.8 |
| School | 13,558 | 2.2 |
| Social | 102,754 | 16.4 |
| Eat Meals | 10,945 | 1.7 |
| Shopping | 108,084 | 17.3 |
| Non-Home Based | 110,379 | 17.7 |
| Home Based Miscellaneous | 113,018 | 18.1 |
| Subtotal | 624,345 | 100.0 |
| TRUCKS | | |
| Light Trucks | 131,374 | 94.8 |
| Heavy Trucks | 7,273 | 5.2 |
| Subtotal | 138,647 | 100.0 |
| TOTAL | 762,992 | |

SOURCE: Salt Lake Area Transportation Study

truck trips classified by purpose. Table II-13 taken from the Transit Improvement Program, page 54, represents the results of a later survey on transit trip purpose.

### 6. Trip Length

The distribution of auto driver trip lengths was again taken from the Salt Lake Area Transportation Study. Table II-14 presents a summary of trip lengths by trip purpose. The average auto driver trip length in 1960 was approximately 9.6 minutes in length.

### 7. Average Daily Driver Trip Ends

Table II-15 presents the estimated 1960 average daily trip ends in Salt Lake. Note that approximately 7.4 percent of all trip ends terminated or began within the CBD.

### 8. Core Area Vehicle Miles of Travel

After an initial review of the vehicular travel and emissions for the entire study area, it was decided to concentrate specifically on the core area as defined in Figure II-8. The original traffic zones were grouped to form sectors.

Table II-16 presents the daily vehicle miles of travel by sector for the years 1971, 1977, 1978 and 1979 based upon expansion factors furnished by the Utah State Department of Highways.

Utilizing the previously described traffic variations and characteristics, estimates were made of vehicles miles of travel for

## TABLE II-13

## COMPARISON OF TRIP PURPOSE ALL MODEL VERSUS TRANSIT

| HOME BASED TRIPS | ALL MODES (1) | TRANSIT (2) |
|---|---|---|
| Work | 17 | 53 |
| School | 6 | 10 |
| Shopping | 12 | 12 |
| Personal Business (3) | 3 | 10 |
| Social-Recreation (4) | 24 | 3 |
| Other (5) | 10 | 5 |
| | 72% | 93% |
| NON HOME BASED TRIPS | 28% | 7% |
| Total | 100% | 100% |

---

(1) Source, Origin Destination Survey, 1960; Table B-2(6), Salt Lake Area Transportation Study, Volume III, Wilbur Smith and Associates, 1965.

(2) Source, Transit Survey, May, 1970.

(3) Includes SLATS Purposes: Business and Medical-Dental

(4) Includes SLATS Purpose: Eat Meal

(5) Includes SLATS Purposes: Change Travel Mode and Serve Passenger.

SOURCE: A Transit Improvement Program, Alan M. Voorhees and Associates, March 1971.

## TABLE II-14

## AUTO DRIVER TRIP LENGTHS BY PURPOSE-1960 INTERNAL SURVEY

| TRIP LENGTH (minutes) | PERCENT OF TOTAL TRIPS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | WORK | PERSONAL BUSINESS | MEDICAL -DENTAL | SCHOOL | SOCIAL-RECR. | EAT MEAL | SHOPPING | NON-HOME BASED | MISCELLANEOUS |
| Intrazonal | 2.26 | 8.04 | 2.31 | 4.41 | 12.04 | 13.35 | 13.44 | 7.05 | 15.79 |
| 1-3 | 3.56 | 9.16 | 5.20 | 9.51 | 9.58 | 6.75 | 17.47 | 14.01 | 14.00 |
| 4-6 | 15.60 | 21.29 | 14.89 | 25.54 | 24.42 | 19.57 | 30.94 | 31.32 | 28.46 |
| 7-9 | 17.99 | 18.63 | 22.09 | 27.36 | 16.97 | 17.89 | 15.04 | 19.55 | 17.99 |
| 10-12 | 16.25 | 13.92 | 16.28 | 10.84 | 12.91 | 14.77 | 8.36 | 12.68 | 9.89 |
| 13-15 | 14.24 | 12.02 | 12.60 | 8.63 | 9.17 | 10.73 | 5.61 | 7.36 | 5.52 |
| 16-18 | 10.33 | 5.44 | 8.03 | 4.59 | 6.07 | 7.12 | 3.67 | 3.85 | 3.72 |
| 19-21 | 8.81 | 4.85 | 9.02 | 2.69 | 3.80 | 4.44 | 2.54 | 2.10 | 2.98 |
| 22-24 | 5.26 | 2.77 | 3.14 | 2.46 | 2.42 | 3.03 | 1.46 | 1.14 | 1.31 |
| 25-27 | 3.04 | 2.67 | 3.21 | 1.90 | 1.48 | 1.74 | 1.07 | 0.57 | 0.76 |
| 28-30 | 1.65 | 0.68 | 2.31 | 1.01 | 0.76 | 0.21 | 0.34 | 0.22 | 0.27 |
| 31 and over | 1.01 | 0.53 | 0.92 | 1.06 | 0.38 | 0.40 | 0.06 | 0.15 | 0.11 |
| TOTAL | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

SOURCE: Salt Lake Area Transportation Study

## TABLE II-15

## AVERAGE DAILY DRIVER TRIP ENDS - BY RESIDENTS - 1960
## CLASSIFIED BY TYPE VEHICLE

| TRIP ENDS | AUTO-DRIVER | TRUCK DRIVER | TAXI DRIVER | ALL DRIVERS | PERCENT |
|---|---|---|---|---|---|
| CBD | 89,192 | 21,253 | 3,523 | 113,968 | 7.4 |
| Non-CBD | 1,159,498 | 256,041 | 12,107 | 1,427,646 | 92.6 |
| Total | 1,248,690 | 277,294 | 15,630 | 1,541,614 | 100.0 |
| Percent | 81.0 | 18.0 | 1.0 | 100.0 | |

SOURCE: Salt Lake Area Transportation Study

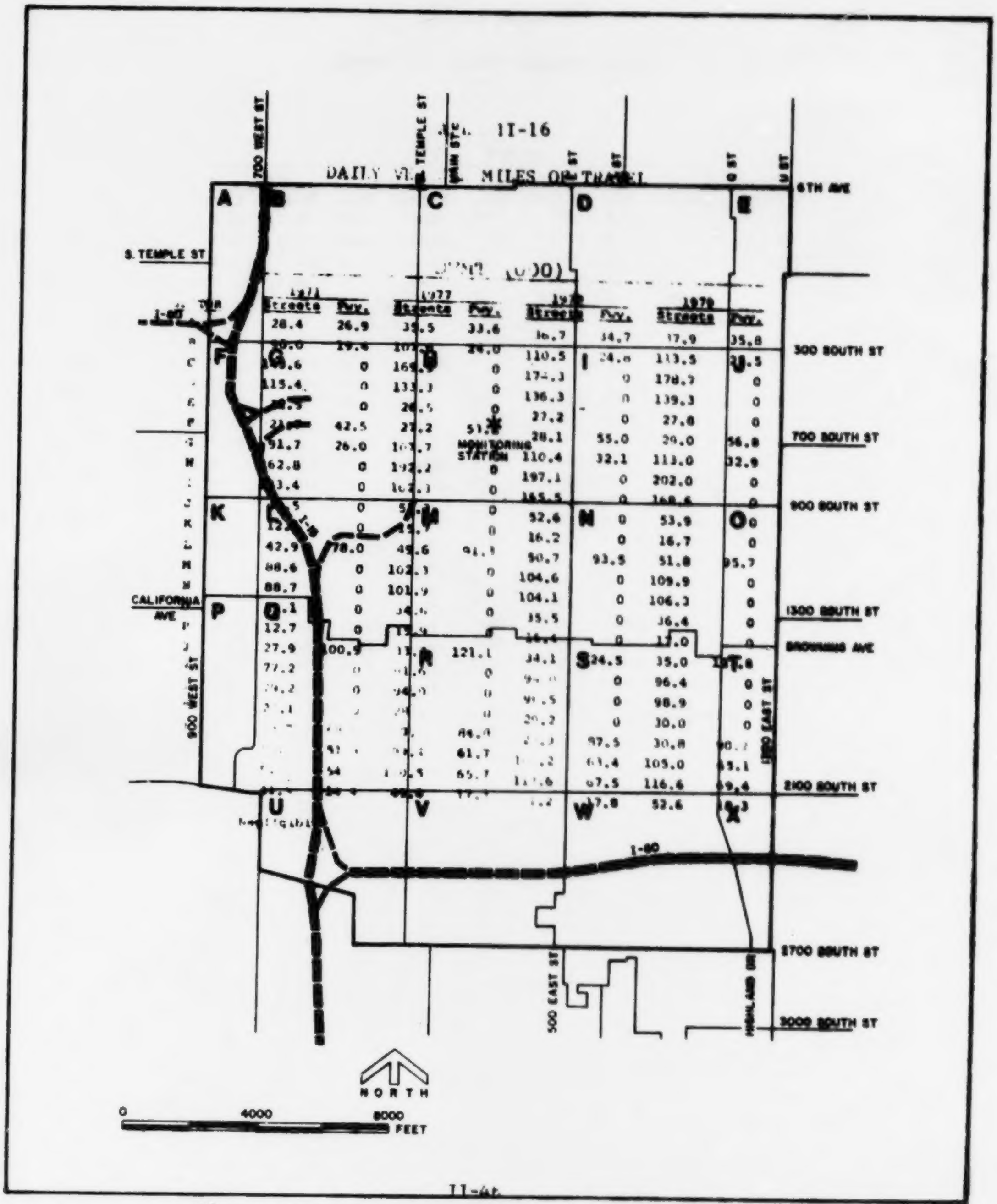

A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S
T
U
V
W
X
700 WEST ST
W. TEMPLE ST
MAIN ST
E ST
ST
U ST
6TH AVE
S. TEMPLE ST
300 SOUTH ST
700 SOUTH ST
900 SOUTH ST
CALIFORNIA AVE
1300 SOUTH ST
BROWNING AVE
900 WEST ST
1300 EAST ST
2100 SOUTH ST
I-80
2700 SOUTH ST
500 EAST ST
HIGHLAND DR
3300 SOUTH ST
MONITORING STATION
NORTH
0
4000
8000
FEET

Figure II-8. Core area sectors - Salt Lake City.

## TABLE II-16

## DAILY VEHICLE MILES OF TRAVEL

| SECTOR | DVMT (000) 1971 Streets | 1971 Fwy. | 1977 Streets | 1977 Fwy. | 1978 Streets | 1978 Fwy. | 1979 Streets | 1979 Fwy. |
|---|---|---|---|---|---|---|---|---|
| A | 28.4 | 26.9 | 35.5 | 33.6 | 36.7 | 34.7 | 37.9 | 35.8 |
| B | 90.0 | 19.4 | 107.6 | 24.0 | 110.5 | 24.8 | 113.5 | 25.5 |
| C | 143.6 | 0 | 169.9 | 0 | 174.3 | 0 | 178.7 | 0 |
| D | 115.4 | 0 | 133.3 | 0 | 136.3 | 0 | 139.3 | 0 |
| E | 22.5 | 0 | 26.5 | 0 | 27.2 | 0 | 27.8 | 0 |
| F | 21.7 | 42.5 | 27.2 | 53.2 | 28.1 | 55.0 | 29.0 | 56.8 |
| G | 91.7 | 26.0 | 107.7 | 31.2 | 110.4 | 32.1 | 113.0 | 32.9 |
| H | 162.8 | 0 | 192.2 | 0 | 197.1 | 0 | 202.0 | 0 |
| I | 143.4 | 0 | 162.3 | 0 | 165.5 | 0 | 168.6 | 0 |
| J | 43.5 | 0 | 51.3 | 0 | 52.6 | 0 | 53.9 | 0 |
| K | 12.6 | 0 | 15.7 | 0 | 16.2 | 0 | 16.7 | 0 |
| L | 42.9 | 78.0 | 49.6 | 91.3 | 50.7 | 93.5 | 51.8 | 95.7 |
| M | 88.6 | 0 | 102.3 | 0 | 104.6 | 0 | 109.9 | 0 |
| N | 88.7 | 0 | 101.9 | 0 | 104.1 | 0 | 106.3 | 0 |
| O | 29.1 | 0 | 34.6 | 0 | 35.5 | 0 | 36.4 | 0 |
| P | 12.7 | 0 | 15.9 | 0 | 16.4 | 0 | 17.0 | 0 |
| Q | 27.9 | 100.9 | 33.2 | 121.1 | 34.1 | 124.5 | 35.0 | 127.8 |
| R | 77.2 | 0 | 91.6 | 0 | 94.0 | 0 | 96.4 | 0 |
| S | 79.2 | 0 | 94.0 | 0 | 96.5 | 0 | 98.9 | 0 |
| T | 23.1 | 0 | 28.3 | 0 | 29.2 | 0 | 30.0 | 0 |
| U | 23.7 | 68.6 | 29.0 | 84.8 | 29.9 | 87.5 | 30.8 | 90.2 |
| V | 82.7 | 51.5 | 99.4 | 61.7 | 102.2 | 63.4 | 105.0 | 65.1 |
| W | 92.1 | 54.7 | 110.5 | 65.7 | 113.6 | 67.5 | 116.6 | 69.4 |
| X | 41.5 | 14.4 | 49.8 | 17.3 | 51.2 | 17.8 | 52.6 | 18.3 |

* Negligible

two specific time periods (6-9 A.M. and 4 P.M. -12 midnight) and by type of vehicle. The results are shown in Tables II-17 through II-20.

## D. DERIVATION OF 1977 AIR QUALITY LEVELS

### 1. General

The methodology presented in Section II-A, which assumes that ambient concentrations are directly proportional to the total emissions of the pollutant over an area of appropriate size, was used to estimate the level of air quality expected in 1977 as a result of the Federal Motor Vehicle Control Program. Independent estimates were made using VMT and air quality data for two reference years: 1970 and 1971. The percent reduction in vehicular emissions required by means of strategies was then estimated by comparing the projected air quality levels with the air quality standards.

Before beginning the detailed calculations, the 1971 VMT data for the entire study area of 110 square miles were examined to ensure consideration of all areas with high emission rates. Figures II-9 and II-10 give the travel densities for the outer and inner zones of the study area, respectively. The figures show that the VMT's per square mile fall off sharply outside of the Core Area. After a review of these data, it was decided to limit the calculation of emission densities to the Core Area, the principal part of which was subdivided into approximate one-mile square zones as was indicated in Figure II-8.

Hydrocarbon emission densities were calculated for the 3-hour period from 0600 to 0900 local time in agreement with the time

## TABLE II-17

## 1971 VEHICLE MILES OF TRAVEL BY TIME PERIOD AND TYPE OF VEHICLE

| | 1971 VMT (000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6 - 9 A.M. | | | | | | 4 - 12 MIDNIGHT | | | | | |
| | FREEWAYS | | | NON-FREEWAYS | | | FREEWAYS | | | NON-FREEWAYS | | |
| SECTOR | Auto | Non-Diesel Truck | Diesel Truck | Auto | Non-Diesel Truck | Diesel Truck | Auto | Non-Diesel Truck | Diesel Truck | Auto | Non-Diesel Truck | Diesel Truck |
| A | 4.4 | .2 | * | 4.8 | .1 | * | 11.1 | .4 | * | 11.9 | .1 | * |
| B | 3.2 | .2 | * | 15.3 | .3 | * | 8.0 | .3 | * | 37.8 | .4 | * |
| C | 0 | 0 | 0 | 24.4 | .4 | * | 0 | 0 | 0 | 60.3 | .7 | * |
| D | 0 | 0 | 0 | 19.6 | .3 | * | 0 | 0 | 0 | 48.5 | .6 | * |
| E | 0 | 0 | 0 | 3.8 | .1 | * | 0 | 0 | 0 | 9.5 | .1 | * |
| F | 7.0 | .4 | * | 3.7 | .1 | * | 17.5 | .6 | * | 9.1 | .1 | * |
| G | 4.3 | .2 | * | 15.6 | .3 | * | 10.7 | .3 | * | 38.5 | .4 | * |
| H | 0 | 0 | 0 | 27.6 | .5 | * | 0 | 0 | 0 | 68.4 | .8 | * |
| I | 0 | 0 | 0 | 24.3 | .4 | * | 0 | 0 | 0 | 60.2 | .7 | * |
| J | 0 | 0 | 0 | 7.4 | .1 | * | 0 | 0 | 0 | 18.3 | .2 | * |
| K | 0 | 0 | 0 | 2.1 | * | * | 0 | 0 | 0 | 5.3 | .1 | * |
| L | 12.8 | .7 | * | 7.3 | .1 | * | 32.1 | 1.0 | .1 | 18.0 | .2 | * |
| M | 0 | 0 | 0 | 15.0 | .3 | * | 0 | 0 | 0 | 37.2 | .4 | * |
| N | 0 | 0 | 0 | 15.1 | .3 | * | 0 | 0 | 0 | 37.3 | .4 | * |
| O | 0 | 0 | 0 | 4.9 | .1 | * | 0 | 0 | 0 | 12.2 | .1 | * |
| P | 0 | 0 | 0 | 2.2 | * | * | 0 | 0 | 0 | 5.3 | .1 | * |
| Q | 16.5 | .9 | * | 4.7 | .1 | * | 41.5 | 1.4 | .1 | 11.7 | .1 | * |
| R | 0 | 0 | 0 | 13.1 | .2 | * | 0 | 0 | 0 | 32.4 | .4 | * |
| S | 0 | 0 | 0 | 13.4 | .2 | * | 0 | 0 | 0 | 33.3 | .4 | * |
| T | 0 | 0 | 0 | 3.9 | .1 | * | 0 | 0 | 0 | 9.7 | .1 | * |
| U | 11.3 | .6 | * | 4.0 | .1 | * | 28.2 | .9 | * | 10.0 | .1 | * |
| V | 8.4 | .4 | * | 14.0 | .2 | * | 21.2 | .7 | * | 34.7 | .4 | * |
| W | 9.0 | .5 | * | 15.6 | .3 | * | 22.5 | .7 | * | 38.7 | .4 | * |
| X | 2.4 | .1 | * | 7.0 | .1 | * | 5.9 | .2 | * | 17.4 | .2 | * |

* Negligible

**Speeds: 6-9 A.M.**

Streets: 15 M.P.H.
Freeways: 50 M.P.H.

**Speeds: 4-12 Midnight**

Streets: 15-19 M.P.H.
Freeways: 50-55 M.P.H.

## TABLE II-18

## 1977 VEHICLE MILES OF TRAVEL BY TIME PERIOD AND TYPE OF VEHICLE

1977 VMT (000)

| | 6 - 9 A.M. | | | | | | 4 - 12 MIDNIGHT | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FREEWAYS | | | NON-FREEWAYS | | | FREEWAYS | | | NON-FREEWAYS | | |
| SECTOR | Auto | Non-Diesel Truck | Diesel Truck | Auto | Non-Diesel Truck | Diesel Truck | Auto | Non-Diesel Truck | Diesel Truck | Auto | Non-Diesel Truck | Diesel Truck |
| A | 5.5 | .3 | * | 6.0 | .1 | * | 13.8 | .5 | * | 14.9 | .2 | * |
| B | 3.9 | .2 | * | 18.3 | .3 | * | 9.9 | .3 | * | 45.2 | .5 | * |
| C | 0 | 0 | 0 | 28.9 | .5 | * | 0 | 0 | 0 | 71.4 | .8 | * |
| D | 0 | 0 | 0 | 22.6 | .4 | * | 0 | 0 | 0 | 56.0 | .6 | * |
| E | 0 | 0 | 0 | 4.5 | .1 | * | 0 | 0 | 0 | 11.1 | .1 | * |
| F | 8.7 | .5 | * | 4.6 | .1 | * | 21.9 | .7 | * | 11.4 | .1 | * |
| G | 5.1 | .3 | * | 18.3 | .3 | * | 12.8 | .4 | * | 45.2 | .5 | * |
| H | 0 | 0 | 0 | 32.6 | .6 | * | 0 | 0 | 0 | 80.7 | .9 | * |
| I | 0 | 0 | 0 | 27.6 | .5 | * | 0 | 0 | 0 | 68.2 | .8 | * |
| J | 0 | 0 | 0 | 8.7 | .2 | * | 0 | 0 | 0 | 21.6 | .3 | * |
| K | 0 | 0 | 0 | 2.7 | .1 | * | 0 | 0 | 0 | 6.6 | .1 | * |
| L | 15.0 | .8 | * | 8.4 | .2 | * | 37.5 | 1.2 | .1 | 20.8 | .2 | * |
| M | 0 | 0 | 0 | 17.4 | .3 | * | 0 | 0 | 0 | 43.0 | .5 | * |
| N | 0 | 0 | 0 | 17.3 | .3 | * | 0 | 0 | 0 | 42.8 | .5 | * |
| O | 0 | 0 | 0 | 5.9 | .1 | * | 0 | 0 | 0 | 14.5 | .2 | * |
| P | 0 | 0 | 0 | 2.7 | .1 | * | 0 | 0 | 0 | 6.7 | .1 | * |
| Q | 19.9 | 1.0 | .1 | 5.6 | .1 | * | 49.8 | 1.6 | .1 | 13.9 | .2 | * |
| R | 0 | 0 | 0 | 15.6 | .3 | * | 0 | 0 | 0 | 38.5 | .4 | * |
| S | 0 | 0 | 0 | 16.0 | .3 | * | 0 | 0 | 0 | 39.5 | .5 | * |
| T | 0 | 0 | 0 | 4.8 | .1 | * | 0 | 0 | 0 | 11.9 | .1 | * |
| U | 13.9 | .7 | * | 4.9 | .1 | * | 34.8 | 1.1 | .1 | 12.2 | .1 | * |
| V | 10.1 | .5 | * | 16.9 | .3 | * | 25.4 | .8 | * | 41.8 | .5 | * |
| W | 10.8 | .6 | * | 18.8 | .3 | * | 27.0 | .9 | .1 | 46.4 | .5 | * |
| X | 2.8 | .2 | * | 8.5 | .2 | * | 7.1 | .2 | * | 20.9 | .2 | * |

* Negligible

Speeds: 6-9 A.M.

Streets: 15 M.P.H.
Freeways: 50 M.P.H.

Speeds: 4-12 Midnight

Streets: 15-19 M.P.H.
Freeways: 50-55 M.P.H.

## TABLE II-19

## 1978 VEHICLE MILES OF TRAVEL BY TIME PERIOD AND TYPE OF VEHICLE

| | 1978 VMT (000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6 - 9 A.M. | | | | | | 4 - 12 MIDNIGHT | | | | | |
| | FREEWAYS | | | NON-FREEWAYS | | | FREEWAYS | | | NON-FREEWAYS | | |
| SECTOR | Auto | Non-Diesel Truck | Diesel Truck | Auto | Non-Diesel Truck | Diesel Truck | Auto | Non-Diesel Truck | Diesel Truck | Auto | Non-Diesel Truck | Diesel Truck |
| A | 5.7 | .3 | * | 6.2 | .1 | * | 14.3 | .5 | * | 15.4 | .2 | * |
| B | 4.1 | .2 | * | 18.8 | .3 | * | 10.2 | .3 | * | 46.4 | .5 | * |
| C | 0 | 0 | 0 | 29.6 | .5 | * | 0 | 0 | 0 | 73.2 | .8 | * |
| D | 0 | 0 | 0 | 23.1 | .4 | * | 0 | 0 | 0 | 57.2 | .7 | * |
| E | 0 | 0 | 0 | 4.6 | .1 | * | 0 | 0 | 0 | 11.4 | .1 | * |
| F | 9.0 | .5 | * | 4.8 | .1 | * | 22.6 | .7 | * | 11.8 | .1 | * |
| G | 5.3 | .3 | * | 18.7 | .3 | * | 13.2 | .4 | * | 46.4 | .5 | * |
| H | 0 | 0 | 0 | 31.5 | .6 | * | 0 | 0 | 0 | 82.8 | .9 | * |
| I | 0 | 0 | 0 | 28.1 | .5 | * | 0 | 0 | 0 | 69.5 | .8 | * |
| J | 0 | 0 | 0 | 8.9 | .2 | * | 0 | 0 | 0 | 22.1 | .3 | * |
| K | 0 | 0 | 0 | 2.8 | * | * | 0 | 0 | 0 | 6.8 | .1 | * |
| L | 15.3 | .8 | * | 8.6 | .2 | * | 38.4 | 1.3 | .1 | 21.3 | .2 | * |
| M | 0 | 0 | 0 | 17.8 | .3 | * | 0 | 0 | 0 | 43.9 | .5 | * |
| N | 0 | 0 | 0 | 17.7 | .3 | * | 0 | 0 | 0 | 43.7 | .5 | * |
| O | 0 | 0 | 0 | 6.0 | .1 | * | 0 | 0 | 0 | 14.9 | .2 | * |
| P | 0 | 0 | 0 | 2.8 | * | * | 0 | 0 | 0 | 6.9 | .1 | * |
| Q | 20.4 | 1.1 | .1 | 5.8 | .1 | * | 51.2 | 1.7 | .1 | 14.3 | .2 | * |
| R | 0 | 0 | 0 | 16.0 | .3 | * | 0 | 0 | 0 | 39.5 | .5 | * |
| S | 0 | 0 | 0 | 16.4 | .3 | * | 0 | 0 | 0 | 40.5 | .5 | * |
| T | 0 | 0 | 0 | 5.0 | .1 | * | 0 | 0 | 0 | 12.3 | .1 | * |
| U | 14.4 | .8 | * | 5.1 | .1 | * | 36.0 | 1.2 | .1 | 12.6 | .1 | * |
| V | 10.4 | .5 | * | 17.0 | .3 | * | 26.1 | .8 | * | 42.9 | .5 | * |
| W | 11.1 | .6 | * | 19.3 | .3 | * | 27.7 | .9 | .1 | 47.7 | .5 | * |
| X | 2.9 | .2 | * | 8.7 | .2 | * | 7.3 | .2 | * | 21.5 | .2 | * |

* Negligible

**Speeds: 6-9 A.M.**

Streets: 15 M.P.H.
Freeways: 50 M.P.H.

**Speeds: 4-12 Midnight**

Streets: 15-19 M.P.H.
Freeways: 50-55 M.P.H.

## TABLE II-20

## 1979 VEHICLE MILES OF TRAVEL BY TIME PERIOD AND TYPE OF VEHICLE

1979 VMT (000)

| | 6 - 9 A.M. | | | | | | 4 - 12 MIDNIGHT | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FREEWAYS | | | NON-FREEWAYS | | | FREEWAYS | | | NON-FREEWAYS | | |
| SECTOR | Auto | Non-Diesel Truck | Diesel Truck | Auto | Non-Diesel Truck | Diesel Truck | Auto | Non-Diesel Truck | Diesel Truck | Auto | Non-Diesel Truck | Diesel Truck |
| A | 5.9 | .3 | * | 6.4 | .1 | * | 14.7 | .5 | * | 15.9 | .2 | * |
| B | 4.2 | .2 | * | 19.3 | .3 | * | 10.5 | .3 | * | 47.7 | .5 | * |
| C | 0 | 0 | 0 | 30.3 | .5 | * | 0 | 0 | 0 | 75.1 | .9 | * |
| D | 0 | 0 | 0 | 23.7 | .4 | * | 0 | 0 | 0 | 50.5 | .7 | * |
| E | 0 | 0 | 0 | 4.7 | .1 | * | 0 | 0 | 0 | 11.7 | .1 | * |
| F | 9.3 | .5 | * | 4.9 | .1 | * | 23.3 | .8 | * | 12.2 | .1 | * |
| G | 5.4 | .3 | * | 19.2 | .3 | * | 13.5 | .4 | * | 47.3 | .5 | * |
| H | 0 | 0 | 0 | 34.3 | .6 | * | 0 | 0 | 0 | 84.8 | 1.0 | * |
| I | 0 | 0 | 0 | 28.6 | .5 | * | 0 | 0 | 0 | 70.8 | .8 | * |
| J | 0 | 0 | 0 | 9.2 | .2 | * | 0 | 0 | 0 | 22.6 | .3 | * |
| K | 0 | 0 | 0 | 2.8 | .1 | * | 0 | 0 | 0 | 7.0 | .1 | * |
| L | 15.7 | .8 | * | 8.0 | .2 | * | 39.3 | 1.3 | .1 | 21.8 | .2 | * |
| M | 0 | 0 | 0 | 16.7 | .3 | * | 0 | 0 | 0 | 46.2 | .5 | * |
| N | 0 | 0 | 0 | 18.0 | .3 | * | 0 | 0 | 0 | 44.6 | .5 | * |
| O | 0 | 0 | 0 | 6.2 | .1 | * | 0 | 0 | 0 | 15.3 | .2 | * |
| P | 0 | 0 | 0 | 2.9 | .1 | * | 0 | 0 | 0 | 7.1 | .1 | * |
| Q | 21.0 | 1.1 | .1 | 5.9 | .1 | * | 52.5 | 1.7 | .1 | 14.7 | .2 | * |
| R | 0 | 0 | 0 | 16.4 | .3 | * | 0 | 0 | 0 | 40.5 | [illegible] | * |
| S | 0 | 0 | 0 | 16.8 | .3 | * | 0 | 0 | 0 | 41.5 | .5 | * |
| T | 0 | 0 | 0 | 5.1 | .1 | * | 0 | 0 | 0 | 12.6 | .1 | * |
| U | 14.8 | .8 | * | 5.2 | .1 | * | 37.1 | 1.2 | .1 | 12.9 | .1 | * |
| V | 10.7 | .6 | * | 17.8 | .3 | * | 26.7 | .9 | * | 44.1 | .5 | * |
| W | 11.4 | .6 | * | [illegible] | .3 | * | 28.5 | .9 | * | 49.0 | .6 | * |
| X | 3.0 | .2 | * | 8.9 | .2 | * | 7.5 | .2 | * | 22.1 | .3 | * |

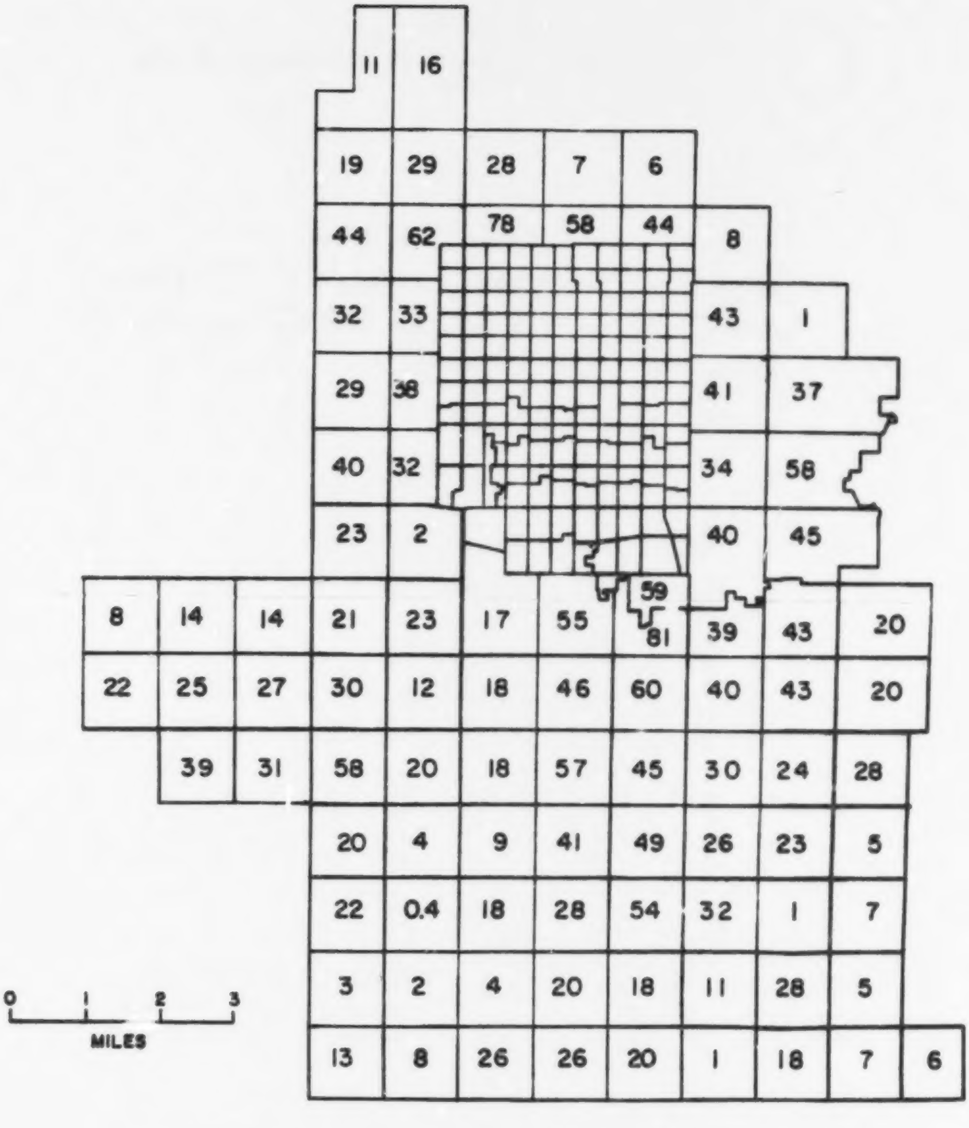
* Negligible

**Speeds: 6-9 A.M.**

Streets: 15 M.P.H.
Freeways: 50 M.P.H.

**Speeds: 4-12 Midnight**

Streets: 15-19 M.P.H.
Freeways: 50-55 M.P.H.



11
16
19
29
28
7
6
44
62
78
58
44
8
32
33
43
1
29
38
41
37
40
32
34
58
23
2
40
45
8
14
14
21
23
17
55
59
81
39
43
20
22
25
27
30
12
18
46
60
40
43
20
39
31
58
20
18
57
45
30
24
28
20
4
9
41
49
26
23
5
22
0.4
18
28
54
32
1
7
3
2
4
20
18
11
28
5
13
8
26
26
20
1
18
7
6
0
1
2
3
MILES

Figure II- 9. Travel densities (thousands of miles per square mile) for zones outside Core Area.

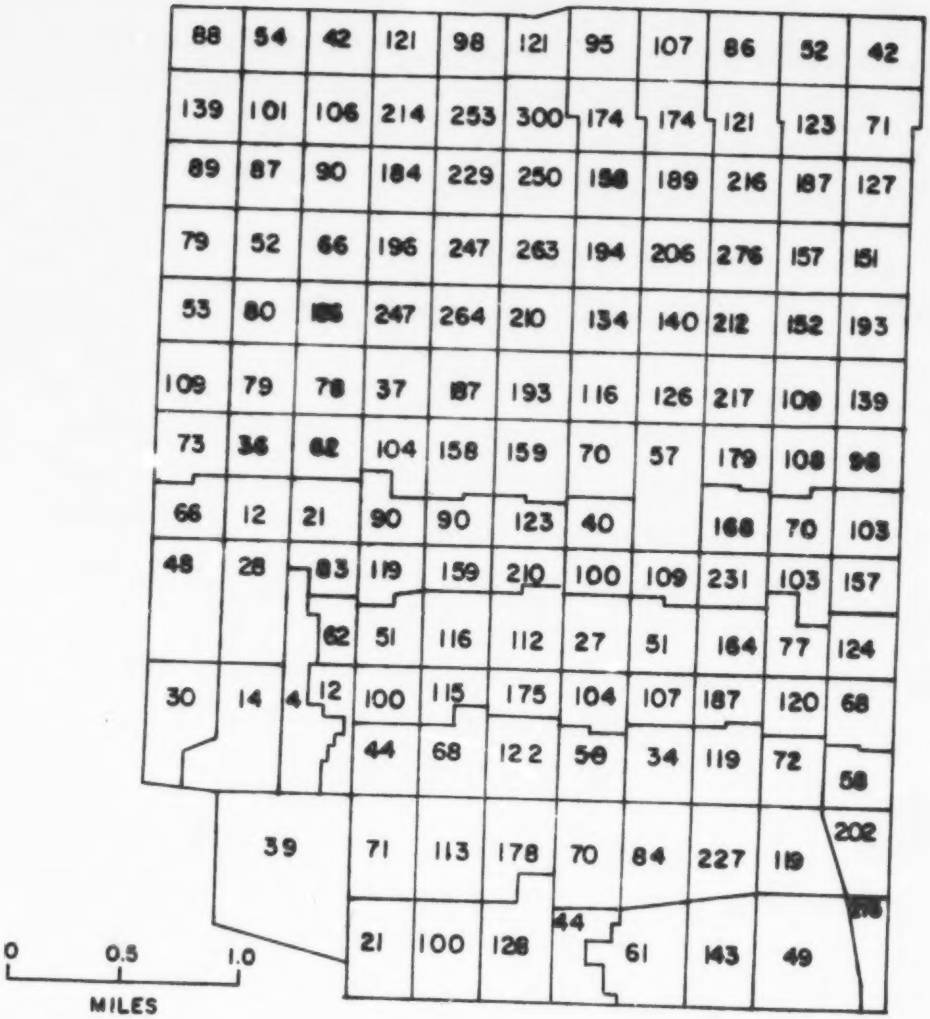

88
54
42
121
98
121
95
107
86
52
42
139
101
106
214
253
300
174
174
121
123
71
89
87
90
184
229
250
158
189
216
187
127
79
52
66
196
247
263
194
206
276
157
151
53
80
155
247
264
210
134
140
212
152
193
109
79
78
37
187
193
116
126
217
109
139
73
36
62
104
158
159
70
57
179
108
98
66
12
21
90
90
123
40
168
70
103
48
28
83
119
159
210
100
109
231
103
157
62
51
116
112
27
51
164
77
124
30
14
4
12
100
115
175
104
107
187
120
68
44
68
122
56
34
119
72
58
39
71
113
178
70
84
227
119
202
21
100
128
44
61
143
49
0
0.5
1.0
MILES

Figure II-10. Travel densities (thousands of miles per square mile) for zones inside Core Area.

period specified by the national standard for hydrocarbons. Carbon monoxide emission densities were calculated for the 8-hour period from 1600 to 2400 local time. This period coincides approximately with the 8-hour period during which CO concentrations are at a maximum during the fall and winter months (see Figure II-1).

## 2. Estimation of CO Levels

### a. Emission Densities within Core Area

### Vehicular Emissions

Emission densities for the 24 zones of the Core Area were calculated for 1971 and 1977 using the traffic data listed in Tables II - 17 and II - 18, respectively, and the EPA emission factors discussed in Section II-A . Emission densities for 1970 were estimated by reducing 1971 VMT's by 3 percent. Figure II-11 shows the resulting emission densities for all zones for 1971 and 1972, and for Zone H, the zone in which the monitoring station is located, for 1970.

### Non-Vehicular Emissions

Table II-21, compiled from data presented in Table V-A and Appendix C of the Implementation Plan, shows that of the 226,110 tons of CO estimated to have been emitted during 1970 within Salt Lake County, only 7,339 tons, or 3.2 percent, are attributed to non-vehicular sources (i.e., sources other than autos and light trucks, and on-highway diesels). Examination of Table II-21 also shows that of these 7,339 tons more than 6,000 tons are emitted from diesels (off hiway), aircraft, and solid waste disposal. These three sources contribute, at most, only small background concentrations to the Core Area. In the proportional modeling, which fol-

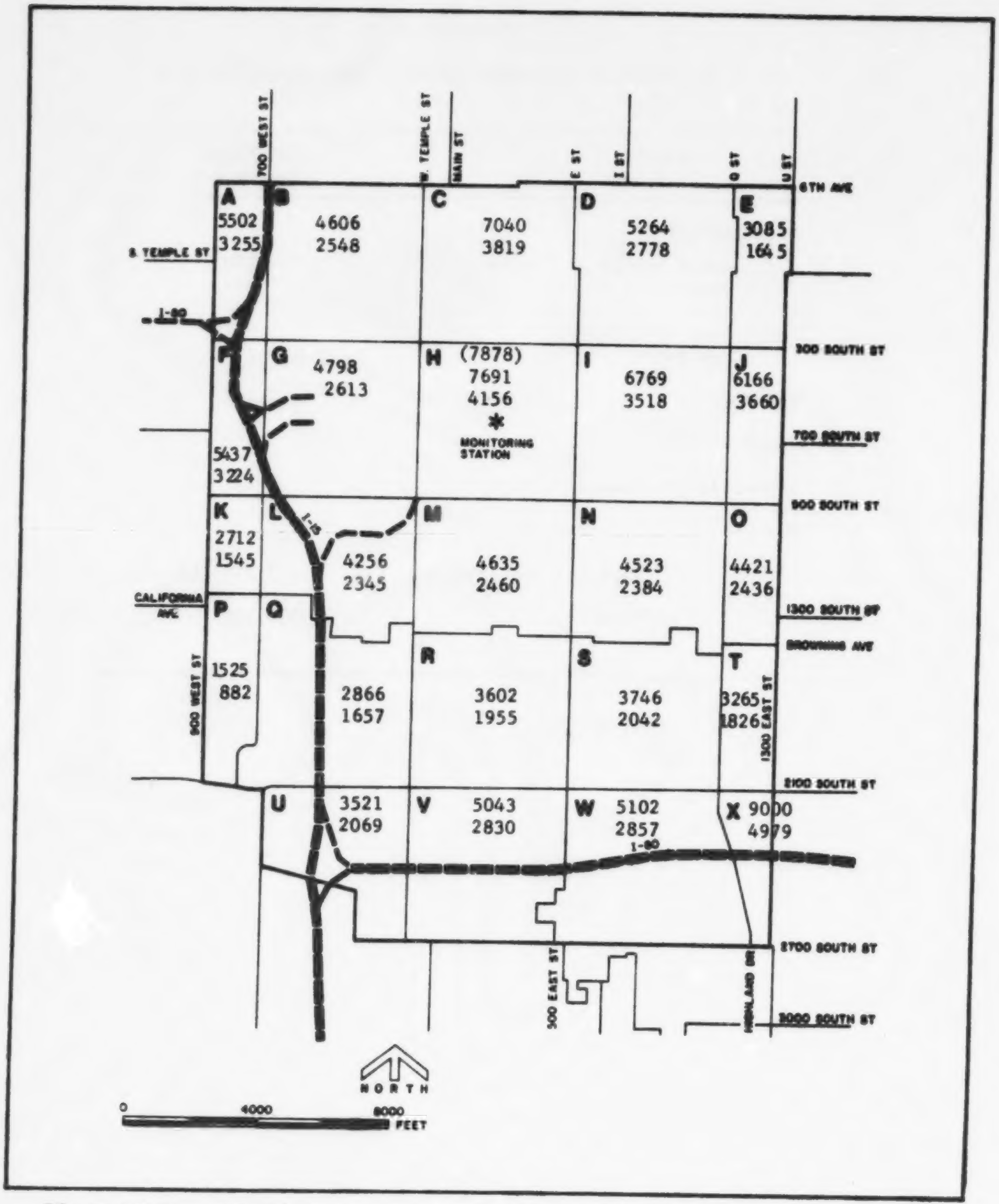

700 WEST ST
W. TEMPLE ST
MAIN ST
E ST
I ST
O ST
U ST
6TH AVE
S TEMPLE ST
I-80
300 SOUTH ST
700 SOUTH ST
900 SOUTH ST
I-15
CALIFORNIA AVE.
1300 SOUTH ST
BROWNING AVE
900 WEST ST
1300 EAST ST
2100 SOUTH ST
I-80
2700 SOUTH ST
500 EAST ST
HIGHLAND DR
3000 SOUTH ST
A
5502
3255
B
4606
2548
C
7040
3819
D
5264
2778
E
3085
1645
F
5437
3224
G
4798
2613
H
(7878)
7691
4156
MONITORING STATION
I
6769
3518
J
6166
3660
K
2712
1545
L
4256
2345
M
4635
2460
N
4523
2384
O
4421
2436
P
1525
882
Q
2866
1657
R
3602
1955
S
3746
2042
T
3265
1826
U
3521
2069
V
5043
2830
W
5102
2857
X
9000
4979
NORTH
0
4000
8000
FEET

Figure II-11. CO emission densities (kg/8-hour/mi$^2$) for 1971 (upper) and 1977 (lower). Value in parentheses (Zone H) is emission density for 1970.

## TABLE II-21

## CO EMISSION ESTIMATES FOR SALT LAKE COUNTY IN 1970

| Source Category | Emissions (Tons/year) |
|---|---|
| Transportation | |
| Autos and Light Trucks | 217,278 |
| Diesel (On Hiway) | 1,493 |
| Diesel (Off Hiway) | 1,992 |
| Aircraft | 2,885 |
| Railroads | 234 |
| Solid Waste | 1,249 |
| Space Heating | 767 |
| Industrial Processes | 152 |
| Electric Power Generation | 60 |
| Subtotal (Non-vehicular) | 7,339 (3.2%) |
| Total | 226,110 |

lows, we attribute 2 percent of the 1970 emissions within the Core Area to non-vehicular sources, and leave their emission rate unchanged for 1971 and 1977.

b. Results

Table II-22 summarizes relevant emission density and air quality data for Zone H of the Core Area. Independent estimates of maximum allowable emission density, air quality, the percent reduction in vehicular emissions expected to be achieved by the Federal Motor Vehicle Control Program, and the percent reduction required from transportation strategies have been made using the two reference years (1970, 1971).

Figure II-11 shows that of the larger Core Area zones (area approximately 0.8 mi$^2$) only Zones C, H, and I exceed the more restrictive of the two maximum allowable emission densities (3128 kg /mi$^2$) in 1977, and that only Zone H exceeds the less restrictive (3996 kg /mi$^2$) allowable emission density.

The high emission density shown for Zone X indicates an area of possible concern. The high value in this zone results from the addition of freeway emissions to a high level of street emissions. It should be borne in mind, however, that this high emission density has been calculated over a small area (0.2 mi$^2$), and that the travel density drops off rapidly in neighboring zones (see Figures II-9 and II-10). Also, as pointed out in Section VI, some reduction in traffic affecting this zone is expected as a result of a freeway loop which is currently under construc-

## TABLE II-22

## SUMMARY DATA FOR ZONE H (CO)

a) Emission Densities (kg/8 hr/mi$^2$)

| Category | Year<br>1970 | 1971 | 1977 |
|---|---|---|---|
| Vehicular | 7878 | 7691 | 4156 |
| Non-vehicular | 161 | 161 | 161 |
| Total | 8039 | 7852 | 4317 |

b) Air Quality (8-hr average in ppm)

| | Year<br>1970 | 1971 | 1977 |
|---|---|---|---|
| Observed (2nd Highest) | 22 | 17 | |
| Estimated | | | |
| From 1970 data | | | 11.8 |
| From 1971 data | | | 9.3 |

c) Maximum Allowable Emissions Level (kg/8 hr/mi$^2$)

| | Total | Vehicular |
|---|---|---|
| Estimated | | |
| From 1970 data | 3289 | 3128 |
| From 1971 data | 4157 | 3996 |

d) Reduction in Vehicular Emissions from 1971 Levels (percent)

| Reference Year | Anticipated from Federal Motor Vehicle Control Program by 1977 | Additional Required by Transportation Control Strategies |
|---|---|---|
| 1970 | 46 | 13 |
| 1971 | 46 | 2 |

tion, but because of uncertainties in the construction timetable the full impact of this freeway has not been incorporated into the 1977 VMT's.

The two estimates of the percent reduction in CO emissions required by transportation control strategies are 13 and 2 percent. Reductions are needed only in Zones C, H, and I.

c. Comparison with Implementation Plan Estimates

Table V-A of the Implementation Plan shows a reduction of 43 percent in total CO emissions in Salt Lake County between 1970 and 1977. The reduction in emissions from autos and light trucks over this period is 46 percent. These figures compare closely with the results for Zone H given in Table II-22. The reduction in total emissions for Zone H between 1970 and 1977 is 46 percent, and the reduction in vehicular emissions is 47 percent.

### 3. Estimation of Oxidant Levels

a. Emission Densities within the Core Area

For the proportional modeling used to estimate air quality for 1977, it is necessary to apportion the total initial hydrocarbon content of the local air mass within which the highest oxidant concentrations are produced to vehicular and non-vehicular sources. No spatial relationship between the source of the hydrocarbons and the region of high oxidant concentrations need be postulated. The following basic assumptions were used in making the apportionment:

(1) The local air mass of concern is the one having the highest hydrocarbon content.

Its source is the Core Area, where maximum vehicular emissions occur.

(2) Hydrocarbons from non-vehicular sources are uniformly distributed throughout Salt Lake City.

(3) The amount of hydrocarbon emissions within Salt Lake City is directly related by population to total emissions within Salt Lake.

## Vehicular Emissions

Figure II-12 shows 1971 and 1977 3-hour hydrocarbon emission densities for the 24 zones of the Core Area, and the 1970 emission density for Zone H. The traffic data used with the EPA emission factors in calculating the 1971 and 1977 emission densities are listed in Tables II-17 and II-18, respectively. VMT's for 1970 were again obtained by reducing the 1971 values by 3 percent.

Average 3-hour emissions in 1970 for the 14 square mile Core Area during the 0600-0900 A.M. period were 4630 kilograms. When adjusted on the basis of traffic flow, this is equivalent to 26,760 kilograms per day.

## Non-Vehicular Emissions

Table II-23, compiled from Table V-C and Appendix C of the Implementation Plan, gives the distribution of hydrocarbon emis-

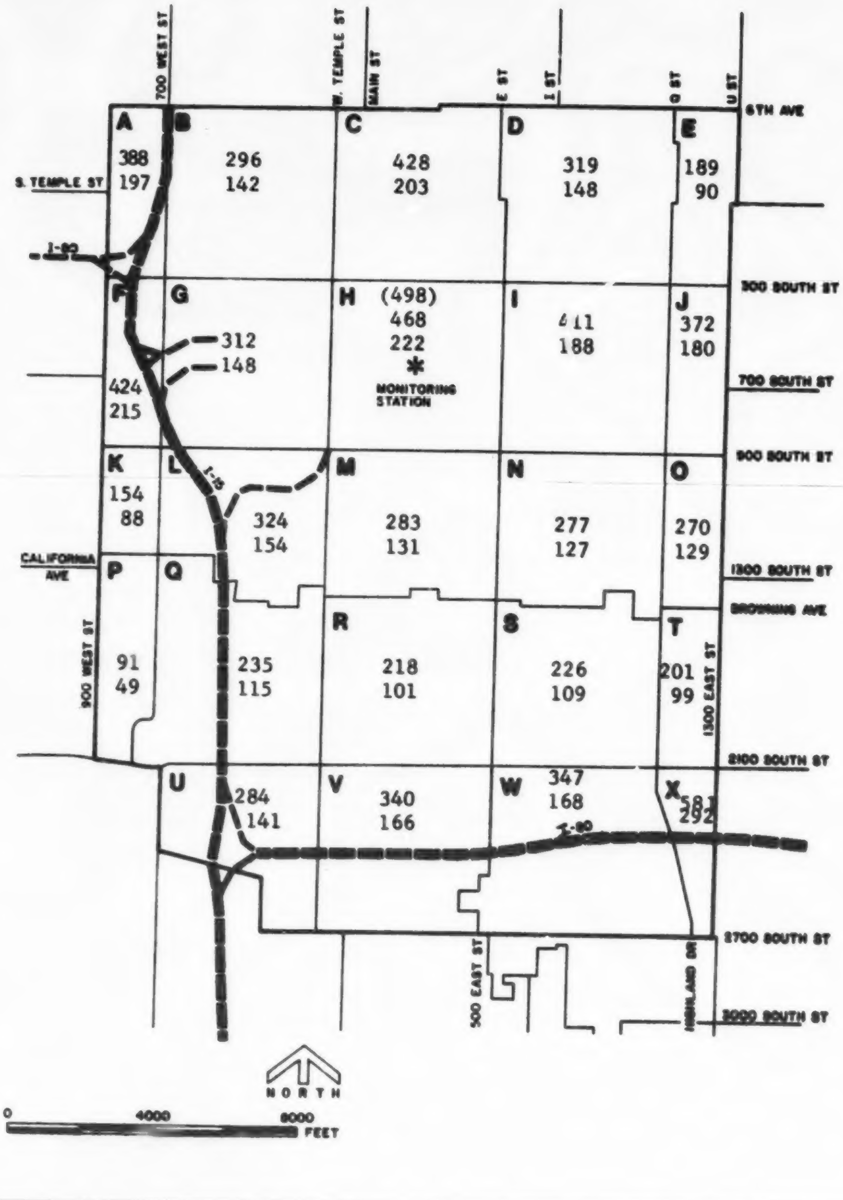

700 WEST ST
W. TEMPLE ST
MAIN ST
E ST
I ST
O ST
U ST
6TH AVE
S. TEMPLE ST
I-80
300 SOUTH ST
700 SOUTH ST
900 SOUTH ST
1300 SOUTH ST
BROWNING AVE
CALIFORNIA AVE
900 WEST ST
1300 EAST ST
2100 SOUTH ST
2700 SOUTH ST
3000 SOUTH ST
500 EAST ST
HIGHLAND DR
I-15
A
388
197
B
296
142
C
428
203
D
319
148
E
189
90
F
424
215
G
312
148
H
(498)
468
222
*
MONITORING STATION
I
411
188
J
372
180
K
154
88
L
324
154
M
283
131
N
277
127
O
270
129
P
91
49
Q
235
115
R
218
101
S
226
109
T
201
99
U
284
141
V
340
166
W
347
168
X
581
292
NORTH
0
4000
8000
FEET

Figure II-12. Hydrocarbon emission densities (kg/3-hour/mi$^2$) for 1971 (upper) and 1977 (lower). Value in parentheses (Zone H) is emission density for 1970.

## TABLE II-23

## HYDROCARBON EMISSION ESTIMATES FOR SALT LAKE COUNTY IN 1970

| Source Category | Emissions (Tons/year) |
|---|---|
| Transportation | |
| Autos and Light Trucks | 36,282 |
| Diesel (On Hiway) | 299 |
| Diesel (Off Hiway) | 398 |
| Aircraft | 2,103 |
| Railroads | 167 |
| Solid Waste | 398 |
| Space Heating | 211 |
| Industrial Processes | 8,742 |
| Electric Power Generation | 683 |
| Gasoline Marketing | 1,775 |
| Subtotal (non-vehicular) | 14,477 (28.3%) |
| Total | 41,058 |

70

sions by source category within Salt Lake County in 1970. The non-vehicular emissions attributed to Salt Lake City were calculated from the county emissions by population as follows:

$$\text{City emissions} = \text{county emissions} \times \frac{\text{city population}}{\text{county population}}$$

$$= 14{,}477 \times \frac{175{,}885}{458{,}607} = 5552 \text{ tons/yr}$$

These emissions were assumed to be evenly distributed throughout the city, and emissions from the Core Area were estimated to be 1442 tons/year or 3580 kg/day using this assumption. Based on these very rough approximations, the non-vehicular emissions make up 12 percent of the total hydrocarbon emissions within the Core Area.

b. Results

Table II-24 summarizes the pertinent emission rates and air quality data for the Core Area. Estimates of emission rates and of air quality were projected from the two reference years of 1970 and 1971. In making these projections, non-vehicular hydrocarbon emissions were assumed to be 12 percent of the total hydrocarbon emissions in 1970, to remain constant in 1971 and to increase by 25 percent by 1977. This is in approximate agreement with the growth rate postulated in Table V-C of the Implementation Plan. Estimates of air quality and allowable emission rates are made by means of curve given in Appendix J of 40 CFR, Part 51.

The estimates in Table II-24 show that the sum of the hydrocarbon emissions expected throughout the Core Area in 1977

## TABLE II-24

## SUMMARY DATA FOR CORE AREA ( HYDROCARBONS-OXIDANTS )

a) Emission Rates of Hydrocarbons (kg/3 hr/14 $mi^2$)

| Category | Year | | |
|---|---|---|---|
| | 1970 | 1971 | 1977 |
| Vehicular | 4633 | 4391 | 2098 |
| Non-vehicular | 632 | 632 | 790 |
| Total | 5265 | 5023 | 2888 |

b) Air Quality - Oxidants (1-hr average in ppm)

| | Year | | |
|---|---|---|---|
| | 1970 | 1971 | 1977 |
| Observed (2nd Highest) | 0.11 | 0.093 | |
| Estimated | | | |
| From 1970 data | | | < 0.08 |
| From 1971 data | | | < 0.08 |

c) Maximum Allowable Emission Level of Hydrocarbons (kg/3 hr/14 $mi^2$)

| | Total | Vehicular |
|---|---|---|
| Estimated | | |
| From 1970 data | 3896 | 3106 |
| From 1971 data | 4470 | 3680 |

d) Reduction in Vehicular Emission of Hydrocarbon from 1971 Levels (percent)

| Reference Year | Anticipated from Federal Motor Vehicle Control Program by 1977 | Additional Required by Transportation Control Strategies |
|---|---|---|
| 1970 | 52 | 0 |
| 1971 | 52 | 0 |

(2888 kg/3 hr/14 mi$^2$) is 26 percent below the more restrictive estimate of the maximum allowable emission level (3896 kg/3 hr/14 mi$^2$). Thus, the calculations indicate that the national standard for oxidants will be met in 1977 without the application of transportation control strategies.

### c. Comparison with Implementation Plan Estimates

Table V-C of the Implementation Plan shows a reduction of 33 percent in total hydrocarbon emissions in Salt Lake County between 1970 and 1977. The reduction in emissions from autos and light trucks over this period is 57 percent. Calculations for the Core Area using the estimates in Table II-D-4 shows a reduction of 45 percent in total emissions and of 55 percent in vehicular emissions between 1970 and 1977.

## E. DISCUSSION OF 1978 and 1979 CARBON MONOXIDE LEVELS

Vehicular CO emission densities were calculated for the 24 zones of the Core Area using the 1978 and 1979 traffic data listed in Tables II-19 and II-20, and the appropriate emission factors. Figure II-13 shows the resulting emission densities for the two years. The emission densities given in Figure II-13 assume no transportation controls. The maximum allowable levels, using 1970 and 1971 as the reference years are, respectively, 3128 and 3996 kg/8-hr/mi$^2$. These estimates are based on an unchanged non-vehicular emission density of 161 kg/8-hr/mi$^2$.

Examination of Figure II-13 shows that, with the exception of Zone X, all emission densities within the Core Area are below the maximum allowable levels in 1979, and that all emission densities for the larger size zones are also below the allowable levels in 1978 except for Zone C and Zone H. Emission densities in these two zones, however, are below the allowable level calculated from the 1971 data.

As pointed out in Section II-D, emission densities given for Zone X are not directly comparable with emission densities of the larger zones because of the small area over which densities of this magnitude exist.

## F. SUMMARY OF PROBLEM AND CONCLUSIONS

The results of the preceding analysis may be summarized as follows:

1. National oxidant standards will be achieved throughout Salt Lake City by 1977 by means of the Federal Motor Vehicle Control Program.

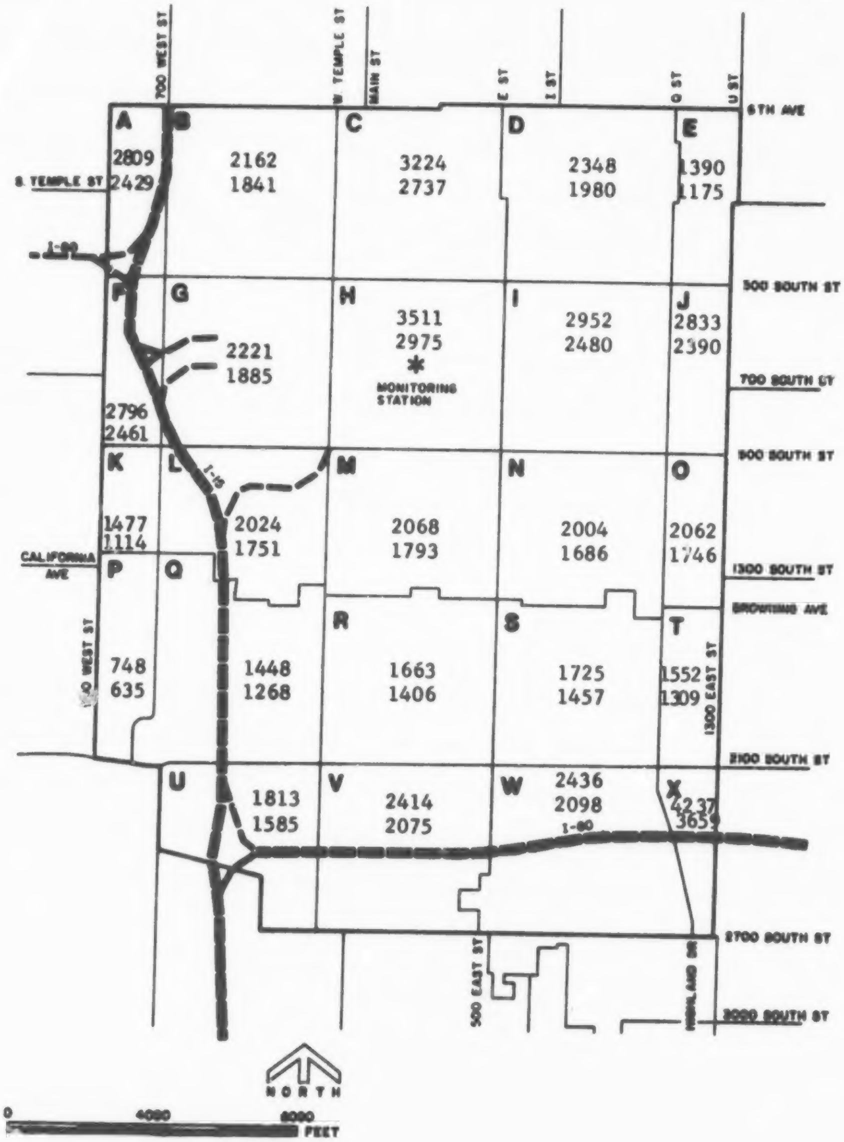

700 WEST ST
W. TEMPLE ST
MAIN ST
E ST
I ST
O ST
U ST
6TH AVE
S. TEMPLE ST
I-80
500 SOUTH ST
700 SOUTH ST
900 SOUTH ST
CALIFORNIA AVE
1300 SOUTH ST
BROWNING AVE
900 WEST ST
1300 EAST ST
2100 SOUTH ST
I-15
2700 SOUTH ST
3000 SOUTH ST
500 EAST ST
HIGHLAND DR
A
2809
2429
B
2162
1841
C
3224
2737
D
2348
1980
E
1390
1175
F
2796
2461
G
2221
1885
H
3511
2975
MONITORING STATION
I
2952
2480
J
2833
2390
K
1477
1114
L
2024
1751
M
2068
1793
N
2004
1686
O
2062
1746
P
748
635
Q
1448
1268
R
1663
1406
S
1725
1457
T
1552
1309
U
1813
1585
V
2414
2075
W
2436
2098
X
4237
3659
NORTH
0
4000
8000
FEET

Figure II-13. CO emission densities (kg/8-hour/mi$^2$) for 1978 (upper) and 1979 (lower).

Transportation control strategies are not required to reduce hydrocarbon emission to acceptable levels.

2. National CO standards will be achieved throughout the city by 1977 by means of the Federal Motor Vehicle Control Program with the exception of a central area bounded approximately by West Temple, 900 South, 500 East, and 6th Avenue. The size of the area judged to be critical depends somewhat on the baseline year (1970 or 1971) used in making the air quality projections.

3. To achieve the 8-hour average CO standard within this central area by 1977 will require an additional reduction in CO emissions from motor vehicles of about 8 percent from 1971 levels. (Individual estimates were 2 and 13 percent, depending upon the baseline year).

4. The Federal Motor Vehicle Control Program is sufficient to ensure that the 1-hour average CO level will remain within the national standard throughout the city.

The above assessment of the oxidant and CO problems in Salt Lake City is in essential agreement with that presented in the Implementation Plan. The more recent data suggests, however, that the CO problem may be less severe than indicated by the 1970 data. Delineation of the critical area was not attempted in the Implementation Plan.

## III. EVALUATION OF CANDIDATE TRANSPORTATION CONTROLS

### A. GENERAL

The potential for reducing vehicle emissions in congested or heavily traveled areas varies from city to city depending upon:

(1) Existing land use patterns

(2) Magnitude and composition of vehicular traffic

(3) The capacity and structure of the existing transportation system

Basically, reductions in vehicle emissions can be accomplished by:

(1) Reducing vehicle miles of travel by

  (a) Reducing number of automobile trips

  (b) Decreasing trip lengths

(2) Optimizing vehicle speeds (30-40 mph)

It has been established in the analyses accomplished during the course of this study that transportation control strategies will be required to meet the 8-hour standard in Salt Lake City by 1977. These strategies are required principally during the fall and winter months.

The following describes several transportation control strategies which could be implemented in Salt Lake City. The strategies listed are not all-inclusive; rather, they include only those practical strategies, based upon limited study and evaluation, which would be most appropriate for Salt Lake City. For a more complete listing of strategies, refer to "Evaluating Transportation Controls to Reduce Motor Vehicle Emissions in Major Metropolitan Areas," prepared by the Institute of Public Administration, in March, 1972. Table III-1 presents a summary of those major transportation control strategies and their impacts as presented in the Institute of Public Administration report.

## 3. MOTOR VEHICLE INSPECTION PROGRAM

Several inspection programs, each designed to enforce a reduction in automobile emissions to an acceptable federal standard, are presented herein to establish a basis for determining the acceptability and impact of a motor vehicle inspection program for the State of Utah. These programs are discussed below.

### 1. Statewide Emission Inspection Program in Conjunction with Vehicle Safety Inspection

Since there are existing federal requirements that states conduct motor vehicle safety inspections, one logical approach would be to expand the existing statewide safety inspection program to include a periodic inspection of motor vehicle emissions. A state vehicle safety inspection program charged with the added responsibility of coordinating with an emissions control program could be an efficient and cost-effective method of implementing an emission inspection program.

When considering a statewide program, it is essential that pertinent criteria be established. From a standpoint of total emission

# TABLE III-1

## IMPACT OF TRANSPORTATION CONTROLS ON TRAVEL PATTERNS AND MOTOR VEHICLE EMISSIONS (CARBON MONOXIDE FROM LIGHT DUTY MOTOR VEHICLES ONLY)

| TRANSPORTATION CONTROL CANDIDATES | IMPACT ON TRAVEL PATTERNS(1) | IMPACT ON MOTOR VEHICLE EMISSIONS(2) |
|---|---|---|
| Short Term (2-5 years) | | |
| Inspection, Maintenance and Retrofit | No changes in modal mix, trip generation or origin-destination patterns. | 10 to 25 percent.(3) Upper range (particularly 20 to 25 percent) decidedly less likely than lower range (particularly 10 percent). |
| Gaseous Fuel Systems | No changes in modal mix, trip generation or origin-destination patterns. | Less than 15 percent.(4) Appropriate only for large, centrally-maintained fleets which account for a relatively high proportion of total vehicle miles traveled (e.g., taxicabs in Borough of Manhattan). |
| Traffic Flow Techniques | No changes in modal mix. Possible increase in trip generation as a result of improvements in traffic flow. No changes in origin-destination patterns, at least for the short-term. | Less than 20 percent.(5) However, emissions appear to decrease for only the year immediately following implementation, after which time emissions may increase above original levels due to growth in traffic volumes. To control traffic volumes, motor vehicle restraints would be required. |
| Bypassing Thru Traffic | No changes in modal mix. Possible increase in trip generation as a result of improvements in traffic flow. No changes in origin-destination patterns, at least for the short-term. | Less than 5 percent.(6) Measures requiring new construction (e.g., circumferential routes) not implementable within 5 years. Modest bypassing may be possible through use of directive signs and/or signals. More substantial bypassing will require motor vehicle restraints. |
| Medium Term (5-10 years) | | |
| Improvements in Public Transportation | Changes in modal mix by improvements in public transport; no change in trip generation or origin-destination patterns at least in the short-term. | Less than 5 percent.(7) Improvements in public transport are a necessary but not sufficient condition for reducing motor vehicle emissions. To have an appreciable effect on emissions public transport improvements must be combined with motor vehicle restraints. Restraining or restricting motor vehicles, however, would require substantial public transport improvements to provide an alternate means of making trips. |
| Motor Vehicle Restraints | Changes in modal mix by improvements in public transport and motor vehicle restraints. Only minor changes in trip generation, or origin-destination patterns at least in the short-term. | 5 to 25 percent.(8) Potential emission reductions depend upon the severity of restraints. Several motor vehicle restraints are administratively feasible. However, the mechanics of imposing motor vehicle restraints are much less of a problem than gaining public acceptance to limit "freedom of the road." |
| Long Term (10-20 years) | | |
| Work Schedule Changes | Changes in modal mix, possible reduction in trip generation (particularly for the journey to work) and changes in origin-destination patterns due to additional recreational trips. | Less than 3 percent.(9) Work trips would be reduced but increased leisure time would probably generate additional recreational trips (although these are likely to be primarily at off-peak periods to and from areas outside the central city). |
| Land Use Controls(10) | Change in modal mix; change in origin-destination patterns; change in trip generation. | Could not be implemented with any appreciable effect on emissions in the short term. Medium and long-term effects not known. |

## TABLE III-1 (Cont.)

(1) Transportation controls are arranged in order of increasing impact upon travel patterns, and hence upon social and economic activity and location of land use. To the extent that these impacts imply increasing social and economic dislocation, each successive transportation control would need correspondingly longer lead times to implement and take effect.

(2) Expressed as percent of emissions attributable to light duty motor vehicles. Highest values are estimates of maximum feasible emission reductions, using data from central cities where control in question appears to have greatest potential for reducing emissions. It is extremely unlikely that any city could achieve maximum reduction from each of controls. Lower values do not represent minimum emission reduction, but rather an estimate based upon moderately favorable conditions. Estimates for improvements in public transportation, motor vehicle restraints and work schedule changes assume a reduction in motor vehicle miles traveled results in equivalent reduction in motor vehicle emissions. All estimates are for initial reductions and do not take into account deterioration (e.g., deterioration of control devices due to accumulation of mileage).

(3) Estimates for inspection and maintenance only.

(4) Estimates for simple conversion from gasoline to LPG or natural gas.

(5) Based on illustrative example assuming a 30 percent increase in networkwide average vehicle speed.

(6) Estimates for traffic which could be bypassed away from central cities as a result of improvements capable of implementation in the short term, but in the absence of motor vehicle restraints.

(7) Estimates for public transportation broadly defined to include mass transit (rapid rail and bus systems) as well as other means of conveyance, such as taxi, demand-responsive systems, car pools and people movers. Estimates are for reductions in traffic in the absence of motor vehicle restraints.

(8) Lower estimates are for doubling downtown parking rates. Higher estimates are for tripling or for quadrupling downtown parking rates, depending upon comprehensiveness of parking control program.

(9) Estimates are for 4-day week, with working days spread over six days, assuming 30 percent of vehicle miles traveled are accounted for by the journey to work and a maximum of 25 percent of the labor force on 4-day week by 1977.

(10) For example, public policy could encourage land use patterns which would minimize distances between home and work, home and school, and home and shops. In addition, residential and commercial development could be promoted around existing rail and bus lines (and such systems extended) so that public transport would be more accessible to a larger portion of the metropolitan population.

Source: Evaluating Transportation Controls To Reduce Motor Vehicle Emissions In Major Metropolitan Areas, Interim Report, Prepared for the Office of Land Use Planning, Office of Air Programs, Environmental Protection Agency by the Institute of Public Administration and Teknekron, Inc., Washington, D.C. March 16, 1972.

control, administration and cost, a statewide inspection program for Utah should meet the following minimum criteria.

(a) Annual Inspection — Some states and a few foreign countries require technical inspections more frequently than once a year. However, until more valid data are available to justify more frequent inspections, a sound program could be established on the requirement of an annual inspection.

(b) Mandatory Inspection for All Gasoline-Powered Vehicles Operating on the Highways — The prescribed inspection should be mandatory for all gasoline-powered vehicles operating on the highways, with the exception of motorcycles. Information on emissions from two-stroke cycle engines is not readily available and until more tests are conducted the impact of motorcycle inspection cannot be estimated.

(c) State Controlled and Monitored — The inspection should be controlled and monitored directly by a state agency. Any delegation of responsibility to lower levels of government or private enterprise should be carefully planned to preserve state control and uniformity of application.

The 1971 state registration figures provided by the Utah Department of Motor Vehicles show a total motor vehicle registration in the state approaching 824,000 vehicles with the following breakdown.

| | |
|---|---|
| Passenger Vehicles | 557,106 |
| Buses | 16,958 |
| Motorcycles | 39,813 |
| Quarter-year Registration (commercial) | 3,894 |
| Trailers | 23,742 |
| Mileage Registration | 1,168 |
| Commercial W/o Weight | 445 |
| Commercial less 6000 lbs | 118,509 |
| Commercial over 6000 lbs | 62,319 |
| Total | 823,954 |

Slightly more than 675,000 motor vehicle inspections would have been necessary in 1971 to provide an annual inspection of all light duty vehicles.

### 2. Regional Inspection Program-Air Pollution Specific

Projections of 1977 vehicle emissions indicate that only the central business district of Salt Lake City will not be able to meet established air quality standards for carbon monoxide. Based upon the 1960 traffic survey*, between 85 and 90 percent of the travel in the SLATS study area is produced by internal (vehicles garaged in the study area) vehicles. Therefore, a regional, including Salt Lake and Davis Counties, inspection program could produce a significant improvement in air quality in downtown Salt Lake with less cost and administrative burden.

A regional inspection program should meet the same minimum criteria discussed previously for the statewide program.

### 3. Transferred Motor Vehicle Inspection Program

This program, if implemented, would require that vehicles be inspected only when the title is transferred. New cars would be exempt. Vehicle transfer information from the State of Utah indicates that approximately 10 percent of all automobiles and pick-ups registered are transferred during any given year. The 1971 registration information shows approximately 824,000 vehicles registered in the State of Utah. Of this total, 675,600 vehicles, or 82 percent, are classified as passenger cars or light-duty trucks (panel and pick-ups).

---

*Salt Lake Area Transportation Study, Vol. 1, Current Travel Inventory, Wilbur Smith and Associates, 1963, p. IV-24.

### 4. Spot Check Program

This program would be based upon a random sample and roadside check of motor vehicles performed by law enforcement officers or special inspection units created for this purpose. In order to have a significant impact on emissions, a sample in the range of 30 to 40 percent would be necessary. The logistics, administration, public acceptance, enforcement and disruption of travel are major objections to this program.

The programs discussed above are not meant to include all possible inspection programs. Rather the list is intended to provide a basis for discussion and comparison of alternative inspection programs or combinations of programs.

### 5. Inspection Test Procedure

Various inspection procedures have been suggested or used to identify vehicles with emission rates which exceed the standards established by the Clean Air Act. Most of these test procedures are still undergoing evaluation and better information will be available in the near future.

The following inspection and/or maintenance procedures for control of CO and HC exhaust emissions have been evaluated:

(1) Visual inspection for the presence of control devices or systems

(2) Requirement of a minor tune-up at specified time interval

(3) Requirement of a major tune-up at specified time interval

(4) Exhaust measurement at "idle" to identify high emitters for subsequent corrective action

(5) Exhaust measurement under load on a dynamometer to identify high emitters for corrective action

(6) Exhaust measurement under load on a dynamometer to diagnose reasons for high emissions and to indicate what corrective action should be taken.[*]

In numerous states, a number of abbreviated versions of automobile exhaust analysis procedures have been proposed for use in mandatory inspections programs. Four of the most popular tests under consideration are: California Certificate of Compliance, Idle Test, Key-Mode Test, and Diagnostic Test. Detailed test data of these four tests are available and are contained in the Northrop report.[**] A description of each test as taken from the Northrop report follows.

---

[*] Control Techniques for Carbon Monoxide, Nitrogen Oxide, and Hydrocarbon Emissions from Mobile Sources, U.S. Dept. of Health, Education and Welfare, 1970 and Exhaust Emission Control Maintenance U.S. Inspection, Roensch, 61st Annual Meeting Air Pollution Control Assn., St. Paul, Minn., June 1968.

[**] Mandatory Vehicle Emission Inspection and Maintenance, Northrop Corp., May, 1971

### a. Certificate of Compliance Inspection Procedure

"Certificate of Compliance testing procedure is presently accomplished by licensed inspection stations within the State of California. The procedure is performed to verify proper operation of vehicle engines and emission control systems, and is required as a condition of vehicle ownership transfer. The test is performed with the vehicle in a static condition and is primarily concerned with assuring that the vehicle emission control equipment is operating within prescribed specification limits. The crankcase ventilation system and exhaust emission control system components are tested for functional performance. Proper engine operation is verified with diagnostic test equipment and the ignition system is observed for indications of cylinder misfire. Idle rpm is adjusted and ignition timing is reset, if necessary. Idle air-fuel ratio is measured and idle mixture adjusted as required. When the engine is adjusted properly and determined to be in proper working order, a Certificate of Compliance is issued. The Certificate of Compliance procedure was modified to include measurement and adjustment of ignition time and point dwell, and measurement and adjustment of air-fuel ratio."

### b. Idle Inspection Procedure

"The term 'idle inspection' is somewhat misleading since the vehicle is also operated at higher rpm (2500) as part of the inspection test cycle. The test mode is more accurately described as a static or light load test, as the vehicle engine is operated without benefit of vehicle road loads. It has been demonstrated that vehicle system malfunctions which result in high emission characteristics at idle rpm frequently contribute to high emissions over a typical load/speed range as measured by the standard seven-mode test. However, the sensitivity of idle testing can be improved by performing additional testing at higher engine speeds. The engine loads experienced during higher rpm operations provide an opportunity to measure effectiveness of off-idle carburetor circuits and to detect additional malfunctions that may contribute to high emissions. During the idle test procedure, engine operations and emission measurements are accomplished at 2500 rpm prior to performing idle measurements. This sequence provides the opportunity for engine temperature stabilization."

### c. Key-Mode Inspection Procedure

"Key-mode testing is a test process that was developed by the Clayton Manufacturing Company. The test is performed on a simple chassis dynamometer at vehicle speeds and load modes that are calculated to reliably expose engine faults. The operational modes are idle, low cruise, and high cruise. After vehicle pre-test activities are performed, the vehicle is positioned on the dynamometer and emission test equipment attached. The initial test mode is at high cruise conditions. The driver accelerates to a speed and load range of 44 to 50 mph and 21 to 30 hp, depending upon vehicle weight. During this period the engine temperature is stabilized. High cruise emission measurements are performed and the vehicle speed and load are reduced to 22 to 30 mph and 6 to 12 hp, depending again upon vehicle weight. After measurement, the vehicle is allowed to return to idle for final measurements prior to post-test operations.

"A set of repair aids has been developed by Clayton in the form of truth tables. The table, when used as an inspection aid, provides diagnostic information to the repair station. In addition to the truth tables, a manual containing usage examples is provided to the repair facility."

### d. Diagnostic Inspection Procedure

"The diagnostic test procedure, if accomplished effectively, identifies specific component failures and allows direction to the vehicle owner to accomplish specific repair functions. This technique may result in reduced repair costs to the vehicle owner. Additionally, the longevity of engine emission control performance may be enhanced.

"The test procedure includes engine load modes that tend to stress certain emission-critical components. Components that fail during the stress conditions may be marginal under normal operating conditions. Replacement of these marginal components may preclude subsequent failure and resultant high vehicle exhaust emissions.

"The vehicle for test is positioned on a chassis dynamometer. Exhaust emission measurement and engine systems measurement instrumentation is attached. The vehicle is then operated throughout a sequence of speed and load ranges that have been chosen to reveal maximum diagnostic information. Pass-fail judgments are based on exhaust emission measurements at selected points in the dynamic cycle. When the vehicle is determined to have excessive emission characteristics, additional measurements of engine systems and components performance are conducted. This process assists in determining the particular component failure causing excessive emissions.

"Some system measurements can be accomplished simultaneously with emission performance testing. In many cases, superior diagnostic data can be accumulated with the vehicle and engine under dynamic conditions, and component failure decisions may be arrived at before vehicle removal from the testing position. However, at other times, it will be necessary to reposition the vehicle within the facility for additional diagnostic tests.

"The inspection test procedure includes a full throttle full load vehicle operating mode. This mode is performed at the test beginning. Throttle position is limited to a point that will not result in transmission downshift. Load application requires judgment on the part of the test driver to preclude excess stress being applied to engine or vehicle. Vehicle age and condition must be taken into account when making the maximum load decision. The intent of this mode is to reveal ignition system failures that may result in high HC emissions. These failures involving ignition components tend to become more apparent with high cylinder pressures as experienced with high loading conditions.

Measurements of ignition waveform with the engine scope during high loads will assist in isolating the malfunctioning component.

"The high cruise test follows the full throttle modes. The high cruise point selection has been 50 mph with an 8 hp road load applied. This load speed range, when accomplished on a dynamometer capable of simulating vehicle inertia, results in an operating condition equivalent to typical high cruise operation or interurban thoroughfares. This mode is effective in measuring carburetor main circuit and power enrichment systems. Failure of carburetor-related components results in excessive CO emissions. The high cruise mode is followed by a decerleration to idle and subsequent idle measurements. Idle measurements are accomplished in the same manner as during idle inspection mode testing and with the same objectives. Measurements are made during deceleration to reveal the effectiveness of deceleration emission control system components. There are various configurations of deceleration control on different makes of vehicles; effectiveness measurement of these devices is difficult with static testing only.

"Diagnosis of failed vehicles is complicated. The variations in logic flow that stem from failure contingencies are so numerous that flow diagraming techniques become overwhelming. The diagnostic tasks are divided into emission control system tests, fuel system tests, ignition system tests, and mechanical system tests. Testing for component failure within these system areas is accomplished during various static engine operating modes (off of the dynamometer). The modes are described as pre-start, idle, off-idle, and special. The specific tasks that may be performed to diagnose malfunctions are shown for each system as they relate to test modes. Pre-start tests generally concern detailed visual inspection of system components. Idle test involves specific emission control components, idle speed and mixture tests and ignition timing, and point dwell inspection. Off-idle testing is concerned with additional fuel system tests involving air cleaners, power enrichment and main circuit carburetor condition. Ignition coil, distributor, plugs and wires are further tested, including mechanical and vacuum advance mechanisms. When mechanical systems component failure such as exhaust or intake valves are suspect, special tests involving static load (power drop) or compression testing is performed.

"The functional flow as described requires a two-man test crew. One technician performs the pretest operation and places the vehicle in testing position of the chassis dynamometer. After vehicle positioning, he operates the vehicle through speed and load ranges as required by the testing procedure. Alternative procedures may be required for diagnostic purposes if failures are discovered. The other technician performs equipment hookup and accomplishes actual emission and diagnostic measurements.

"The entire task can be accomplished by a single technician; however, the test time must be extended considerably. The single man procedure requires that the emission test be accomplished first, followed by dynamic diagnostic measurements as may be required for failure analysis."

Table III-2 summarizes the foregoing described test procedures.

Test data are available for the above described test. Other types of tests considered fall within the limits of the tests described above for effectiveness, so only the four tests described above will be used for evaluation and ultimate recommendations.

### 6. Impact on Vehicle Emissions

In estimating exhaust emission reductions per vehicle for an inspection-maintenance program, EPA shows the following:*

| | |
|---|---|
| Hydrocarbons | 12 percent |
| Carbon monoxide | 10 percent |
| Nitrogen oxides | 0 percent |

These reductions are based on data which show a maximum effectiveness immediately after maintenance of 25 percent and 19 percent for hydrocarbons and carbon monoxides, respectively, and an assumption of straight line deterioration to zero percent effectiveness over a 12-month period.

Obviously the total impact on emission would approach these individual vehicle figures if the inspection program was implemented on a

---

*Control Strategies for In-Use Vehicles. Office of Air and Water Programs, Mobile Source Pollution Control Program, Washington, D. C., Nov. 1972.

## TABLE III-2

## TEST PROCEDURE SUMMARY

| FUNCTIONS | CERTIFICATE OF COMPLIANCE | IDLE | KEY-MODE | DIAGNOSTIC |
|---|---|---|---|---|
| **Pretest Inspection** | | | | |
| Exhaust System | X | X | X | X |
| Engine/Fuel System | X | X | X | X |
| Tire Condition | | | | |
| Record Vehicle Data | X | X | X | X |
| **Test Functions** | | | | |
| Idle rpm | CO | HC,CO,NO | HC,CO,NO | HC,CO,NO |
| 2500 rpm | | HC,CO,NO | | |
| 30 mph cruise | | | HC,CO,NO | |
| 50 mph cruise | | | HC,CO,NO | |
| 50 mph - 8hp cruise | | | | HC,CO,NO |
| Max. Throttle Load | | | | HC |
| Decel. from 50 mph | | | | HC |
| PVC System Test | X | | | X |
| Exhaust Control System | X | | | X |
| Ignition Timing Test | X | | | X |
| Engine Condition Test | HC,CO | | | X |
| Ignition Timing Adjust | X | | | |
| Idle Mixture Adjust | X | | | |

SOURCE: Northrop Report, June, 1971.

statewide basis. For a regional inspection program, the impact would be somewhat less, probably varying in proportion to the percentage of vehicles registered in the region to the total state registration. The 1971 registration figures show that Salt Lake and Davis Counties comprise approximately 52 percent of the total state motor vehicle registrations. The SLATS study estimates that between 85 and 95 percent of the vehicular travel was by vehicles garaged within the SLATS study area, including Salt Lake and a portion of Davis County.

### 7. Cost Analyses

The cost of implementing an inspection/maintenance program will vary depending upon the type of inspection program initiated. The following table shows a comparison in the costs of initiating and operating three different test regimes.

COMPARATIVE COSTS OF
IDLE, KEY MODE, AND DIAGNOSTIC TESTS*

| TEST REGIME | INVESTMENT COST FACTOR | OPERATING COST FACTOR |
|---|---|---|
| Idle | 1.00 | 1.00 |
| Key Mode | 1.64 | 1.12 |
| Diagnostic | 7.34 | 3.20 |

Primary considerations for implementing a vehicle emissions inspection program are: (1) cost to the average owner, and (2) the benefits derived from the program. As an example, the following table (Table III-3) shows the cost/benefit ratios of the three tests mentioned above. This table

---

*Northrop Report, June 1971.

### TABLE III-3

### ESTIMATED COST EFFECTIVENESS USING SEVERAL TYPES OF INSPECTION/MAINTENANCE

| TYPE OF INSPECTION AND/OR MAINTENANCE | AVERAGE TOTAL ANNUAL OUT-OF-POCKET COST PER CAR INCL. REPAIRS | | IMMEDIATELY AFTER SERVICE PERCENT REDUCTION | | | COST-BENEFIT RATIOS $/CAR/PCT. REMOVED | | |
|---|---|---|---|---|---|---|---|---|
| | Year | Cost | HC | CO | NOx* | HC | CO | NOx |
| Key-Mode Diagnosis | 1975 | 21.80 | 20.9 | 34.0 | ( 7.0) | 1.04 | 0.64 | - |
| | 1977 | 24.00 | 17.9 | 35.4 | ( 7.5) | 1.34 | 0.67 | - |
| | 1980 | 27.60 | 15.4 | 36.1 | (11.2) | 1.79 | 0.76 | - |
| Idle | 1975 | 8.63 | 20.2 | 28.6 | ( 4.5) | 0.42 | 0.30 | - |
| | 1977 | 9.50 | 15.9 | 30.6 | ( 5.7) | 0.59 | 0.31 | - |
| | 1980 | 10.92 | 15.4 | 33.7 | ( 9.6) | 0.70 | 0.32 | - |
| Diagnostic | 1975 | 16.00 | 13.6 | 22.3 | ( 7.0) | 1.17 | 0.71 | - |
| | 1977 | 18.20 | 11.2 | 23.0 | ( 7.1) | 1.62 | 0.79 | - |
| | 1980 | 21.95 | 8.8 | 19.4 | (12.9) | 2.49 | 1.13 | - |

* (7.0) Indicates increase in NOx
The percent reductions of HC,CO, and NOx shown in the table represent an estimated average reduction in all vehicles tested, including those not equipped with emission control devices.

Source: Northrop Report and "Control Techniques for Carbon Monoxide, Nitrogen Oxide, and Hydrocarbon Emissions from Mobil Sources" - U.S.Dept. of Health, Education, and Welfare.

is also shown in graphic form for a quick comparison of the three tests in Figure III-1.

There are several factors to be considered in determining which of the many alternatives would be most suitable for implementation, such as future regulations, technological advancements by the manufacturers of automobile engines, and prototype developments.

Other analyses of the cost-effectiveness of the inspection/maintenance strategy are contained in the November 1972 EPA report previously referred to entitled "Control Strategies for In-Use Vehicles".

## C. RETROFIT REQUIREMENT

Retrofit, as defined for this study, is the installation of emission control equipment on automobiles which were not initially equipped with such devices by the manufacturer. This evaluation of a retrofit requirement considers the benefits derived in terms of automobile emission reduction from two alternative conditions: (1) the emission reduction resulting from requiring retrofit in all uncontrolled automobiles (pre-1968 models), and (2) the emission reduction resulting from a retrofit requirement when an uncontrolled used automobile is transferred.

Table III-4 shows the percent of cars in use and the corresponding percent of annual vehicle miles traveled by various ages of automobiles on a national average. Based on this table, approximately 90 percent of the automobiles in use in 1977 will have been manufactured after 1967 and thus

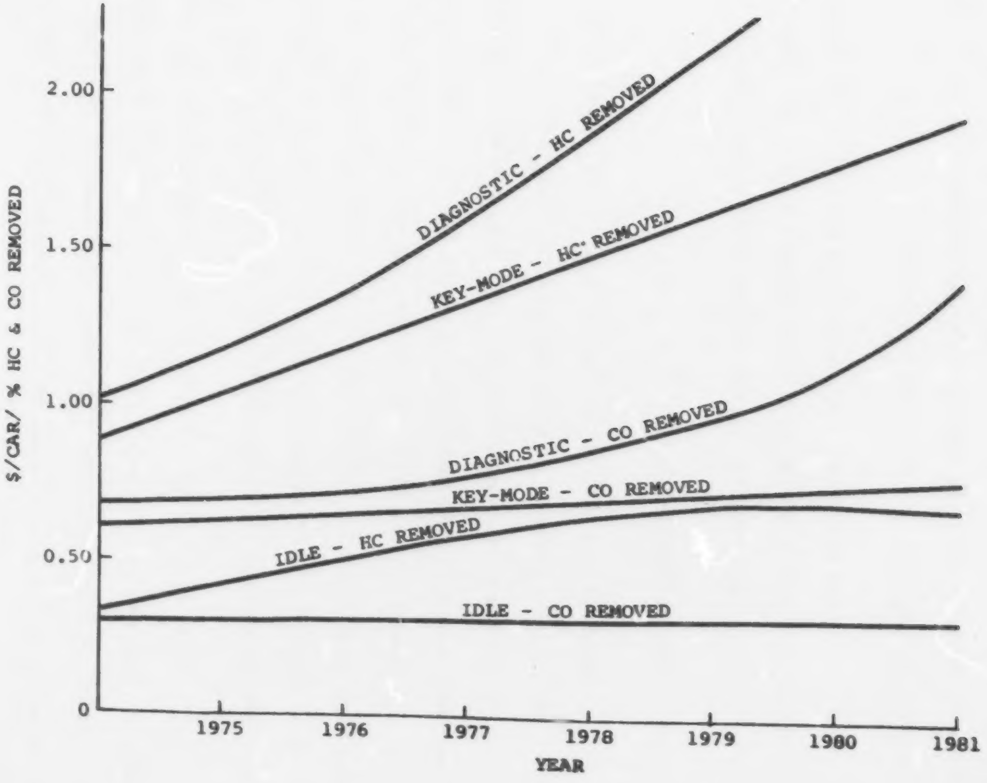


Figure III-1. Cost-Benefit Comparisons.

## TABLE III-4

## VEHICLE MILES OF TRAVEL BY AGE OF VEHICLE

| Age (year) | Percent of Autos In Use (Dec. 31) | Average Annual Travel | Percent of Annual Travel |
|---|---|---|---|
| 0 | 3.8 | 3,600 | 1.3 |
| 1 | 6.8 | 11,900 | 7.5 |
| 2 | 11.7 | 16,100 | 17.4 |
| 3 | 11.1 | 13,200 | 13.5 |
| 4 | 9.8 | 11,400 | 10.3 |
| 5 | 10.6 | 11,700 | 11.5 |
| 6 | 10.5 | 10,000 | 9.7 |
| 7 | 8.7 | 10,300 | 8.3 |
| 8 | 7.6 | 8,600 | 6.0 |
| 9 | 5.9 | 10,900 | 5.9 |
| 10 | 3.6 | 8,000 | 2.7 |
| 11 | 2.9 | 6,500 | 1.7 |
| 12 | 1.6 | 6,500 | 1.0 |
| Over 12 | 5.4 | 6,500 | 3.2 |

Source: Environmental Protection Agency, October 1972.

be equipped by manufacturers with at least some emission control devices. Travel by automobiles manufactured prior to 1968 (10 percent of total automobiles) will contribute only 6 percent of the total automobile vehicle miles of travel. However, some 58 percent of all cars in use in 1977 will be from the 1968-1974 model years and can thus benefit from a retrofit program using oxidizing catalytic converters, for example. These "controlled" vehicles will contribute over 54 percent of the total VMT in 1977.

The distribution of vehicles by year model for Salt Lake County is shown in Table III-5. If these percentages are projected to 1977 it will indicate that approximately 83 percent of the automobiles in use in 1977 will have been manufactured after 1967 and thus be equipped with some sort of emission control devices; however, only the top 25 percent (1975 and later model years) will come from the manufacturer in a "fully-controlled" condition. The remaining 58 percent would be candidates for a retrofit program of the kind already mentioned above.

The State of California pre-empted the federal Clean Air Act and required crankcase emission control devices on automobiles beginning with the 1966 models. Recently enacted legislation will require, beginning March 1973, that all vehicle models from 1955 through 1965 registered in California be equipped with one of two emission control devices which have been tested and approved by the State. The cost of the least expensive device which includes installation, is $35.00. The more expensive one costs $65.00.

## TABLE III-5

## VEHICLE DISTRIBUTION BY MODEL YEAR
## (SALT LAKE COUNTY)

| YEAR MODEL | PERCENT OF AUTOS IN USE |
|---|---|
| 1971 | 7.3 |
| 1970 | 8.5 |
| 1969 | 9.6 |
| 1968 | 9.2 |
| 1967 | 8.6 |
| 1966 | 9.1 |
| 1965 | 9.3 |
| 1964 | 8.1 |
| 1963 | 7.4 |
| 1962 | 6.2 |
| 1961 | 4.2 |
| 1960 | 3.5 |
| 1959 | 2.4 |
| 1958 | 1.1 |
| 1957 | 1.3 |
| 1956 | 1.2 |
| Prior to 1956 | 3.0 |

**Source:** Compiled from official state records by R.L. Polk and Co.

It is estimated that about 10 percent of used cars are transferred each year in Utah. By incorporating this figure (6 percent of vehicle miles of travel x 10 percent transferred) in the above data, it can be seen that benefits resulting from a retrofit requirement when the vehicle is transferred would apply to less than one percent of the total automobile miles of travel, if we restrict our attention to uncontrolled (pre-1968) models only.

Based upon the very small amount of vehicle miles of travel which will be performed by vehicles manufactured prior to 1968, retrofit of these uncontrolled vehicles should not be a consideration in the control strategies for reducing emissions in a program implemented as late as 1977.

## D. TRAFFIC FLOW IMPROVEMENTS

Traffic flow improvements refer to those traffic engineering measures that have as their principal objective a reduction in delays, idling periods, and stops and starts, which, in turn, tends to increase average vehicle speeds.

Due to the existing wide streets in downtown Salt Lake City and the constant effort being made by the Traffic Engineering Department, additional traffic flow improvement programs may yield only limited reductions in emissions. However, in many ways traffic flow improvement techniques are relatively easy to implement. Federal funding for such programs is currently available through the TOPICS (Traffic Operations Program to Increase Capacity and Safety) program.

### 1. Traffic Signal System

Salt Lake City has just completed a city-wide TOPICS study and has a number of TOPICS projects available for early implementation. The most significant TOPICS project includes a Computer Central Signal Control System which will modernize and improve existing signalization within a 300 square block area within the central business district of Salt Lake City. This system generally covers the area bounded by 2nd West, 21st South, 13th East and North Temple. Table III-6 presents a brief description of the proposed system and its benefits.

The estimated cost of the proposed signal system is $400,000 with three-fourths ($300,000) coming from federal TOPICS funds and $100,000 from local funds.

### 2. Impact on Vehicle Emissions

Simply stated, motor vehicle exhaust emissions (carbon monoxide and hydrocarbons) are less in free-flowing traffic than in congested, stop and go conditions. There is some evidence to suggest that the opposite is true for nitrogen oxides.

The degree of improvement depends in large measure upon the baseline speeds prior to implementation of traffic flow techniques. For example, increasing average speeds from 5 to 10 miles per hour produces a much greater reduction in vehicle emissions than an increase from 25 to 30 miles per hour.

## Table III-6

## COMPUTER CENTRAL SIGNAL CONTROL SYSTEM

### Salt Lake City TOPICS Project

| INTERSECTION | IDENTIFIED PROBLEM | RECOMMENDED IMPROVEMENT | EXPECTED BENEFIT |
|---|---|---|---|
| A portion of the central computer controlled system bounded by 2nd West, 9th South, 5th East, 4th South, 9th East, and 3rd Avenue-North Temple. | The existing signal system<br>a) timing plan implementation capability is inadequate<br>b) timing is outdated and in need of update<br>c) subarea configuration does not reflect today's traffic requirements<br>d) subarea relationships permit no inter-subarea coordination<br>e) signal visibility is inadequate. | a) Install central digital computer master, develop operating system software, and, construct connection to telephone company facilities for leased telephone company interconnection system.<br>b) Modify local controllers to provide computer compatible operation.<br>c) Upgrade vehicle and pedestrian visibility as required. | a) The computer and new communications system will permit a highly efficient reshaping of the system into subarea control areas which fulfill overall system demands. It will also permit the implementation of a much wider variety of timing plans.<br>The net result of these improvements will be to reduce motorist delay and decrease travel time within the system.<br>b) The upgrading of traffic signal and pedestrian signal displays will contribute to a more consistent and higher quality signal head visibility and therefore a safer system. |

SOURCE: Salt Lake City TOPICS Study
Peat, Marwick, Mitchell and Co., 1972

In the long run, as new capacity and ease of movement are increased, there is the possibility that additional traffic will be generated to somewhat offset the initial benefits in reduced vehicle emissions. For Salt Lake City, given the level of service on the existing street system, it is not expected that an immediate increase in street capacity would be offset by new generated traffic. There simply is not enough congestion to suppress automobile traffic in Salt Lake City.

Normal traffic growth will, however, continue at a rate of 3 to 4 percent per year. According to projections provided by the Utah State Department of Highways, traffic in the downtown core will increase approximately 18 percent between 1971 and 1977. Thus normal traffic growth will to some extent tend to vitiate the initial benefits resulting from improved traffic flow.

A number of "before-and-after" studies have been conducted to verify the effects of new improved traffic signal systems. At this point in time, it is extremely difficult to judge the true effectiveness of these new signal systems. Not only do the results vary somewhat from city to city, but very few studies have really studied the overall impact for an entire street network.

Perhaps the major source of accurate information comes from the NCHRP Report 113, Optimizing Flow on Existing Street Networks. This report showed increases in travel speed ranging from 9.8 to 121.6 percent in Newark, resulting from improved signal progression. In Louisville, the increased speeds ranged from 0.7 to 24.3 percent.[*]

In Kansas City, Missouri, an improved signal timing program (SIGOP) produced 18.5 percent fewer stops and increased speeds 12.2 percent. These results were obtained without a modern computerized signal system.[**]

Stanford Research Institute reported the following results were obtained through computerized traffic signal systems:

| | |
|---|---|
| New York | 20-40 percent reduction in travel time |
| London | 9 percent reduction in journey time |
| Toronto | 8 to 37 percent reduction in delay |
| Glasgow | 12 percent reduction in journey time |
| San Jose | 10 to 12 percent reduction in delay |

Based primarily on the more comprehensive study report in NCHRP Report 113, it is anticipated that an increase in vehicular speeds of 25 to 30 percent can be expected as a result of the proposed computerized signal system in Salt Lake City. Thus the average peak hour speeds would be expected to increase from approximately 15 to 19 miles per hour.

---

[*] Highway Research Board, Optimizing Flow on Existing Street Networks, National Cooperative Highway Research Program Report 113 (Washington, D.C.: National Academy of Sciences-National Academy of Engineering, 1971).

[**] Department of Transportation News, Federal Highway Administration, Washington, D. C., January 11, 1971.

## E. PERIPHERAL PARKING

### 1. General

This strategy is aimed at intercepting CBD- bound vehicles at strategically located off-street parking facilities on the periphery of the CBD. More specifically, the parking facilities should be outside the problem area of maximum vehicle emission.

The success of the "auto intercept" strategy depends on various measures such as:

(a) Convenient automobile access to fringe parking facilities

(b) Frequent and low-fare transit connecting the parking facilities with CBD destination

(c) A coordinated parking program which can adjust the location of new parking facilities and the rates of all existing facilities to encourage use of the fringe facilities

A recent study of peripheral parking in Los Angeles suggests the following planning guidelines for a peripheral parking program.*

(a) Major intercept terminals should be located prior to the point of major route convergence

(b) Interception of motorists by shuttle bus or micro-bus systems should minimize the travel time between points of interception and the core

(c) The combined parking and transit cost should be less than comparable service supplied by other core parking facilities

(d) Parking capacity should be scaled to approach roadway capacity and parking demand

---

*A Peripheral Parking Program, Central City, Los Angeles, Wilbur Smith and Associates, May 1972.

(e) Facility locations should permit transit riding from all major activity centers located in the downtown area, thereby permitting balanced routing patterns and patronage levels

(f) Intercept transit service should be coordinated with internal secondary distribution systems and other transit facilities (rapid transit to provide an interconnected system of transportation)

(g) Intermediate riding should be encouraged through low and free fares depending upon technology applied

(h) Land use attractions at the outer intercept terminals should help to balance patronage and stimulate reverse riding

(i) Routes, stops, and the vehicles should be clearly identified and separated from current transit facilities

(j) Acquisition and construction costs of parking facilities should be kept to a minimum

It must be emphasized that the concept of peripheral parking as outlined above includes as a necessary ingredient an effective, coordinated, low fare transit service connecting the peripheral parking with all major activity centers in the downtown area. Thus the peripheral parking concept, by definition, includes a mass transit system.

Incidentally, a transit system serving activity centers downtown can have a significant secondary effect. In addition to intercepting vehicles at the periphery of the CBD, the transit system can have a significant impact on circulating traffic in the CBD. In other words, an efficient, attractive transit system can induce people to use transit when travelling between points within the CBD, thereby reducing automobile travel. The recent TOPICS study verified the "continuous circulating traffic in the CBD all day long".

The success of the peripheral parking concept depends greatly upon the overall parking policy. The location and pricing of curb and off-street parking must be coordinated to discourage automobile travel within the core area of downtown Salt Lake City. Obviously the present policy of providing an abundant supply of inexpensive parking throughout downtown must be revised. Motorists must be charged premium prices for parking in congested areas to encourage use of peripheral parking and transit. Only through an effective overall coordinated program, including parking, transit and land use controls, can there be any hope of reducing the use of automobile travel (and vehicle emissions) in downtown Salt Lake.

It is understood that currently Salt Lake City is planning for a pedestrian mall on State Street. This mall as presently envisioned will have little or no impact on vehicle emissions. While there will be some diversion of traffic to adjacent streets, it is safe to assume that there will be no reduction in total travel due to the mall. However, the concept of CBD pedestrian oriented malls combined with peripheral parking and transit present an interesting and worthwhile concept which should be explored thoroughly. A well designed pedestrian mall could provide a significant positive impact on travel within downtown, especially when incorporated in a program of peripheral parking and transit. A well planned CBD which includes pedestrian malls and transit could also provide interesting opportunities for downtown revitalization.

### 2. Impact on Vehicle Emissions

The peripheral parking strategy as defined above, produces an impact on vehicle emissions by reducing vehicular travel within the CBD. However, this strategy can have a profound impact on the entire central business district. For example, a circulating transit system with peripheral parking can produce opportunities for new land use patterns related to mass transit.

It is extremely difficult to estimate the impact on vehicle emission as a result of the suggested peripheral parking program. The magnitude of the impact depends greatly upon the fare structure developed for the parking and transit system. It also depends to some extent on the design and location of the peripheral parking facilities.

In Los Angeles, based upon extensive surveys, the adopted peripheral parking program contains four parking sites estimated to serve approximately 11,300 parkers daily. This represents approximately 11 percent of present parking demand in Central City Los Angeles. Assuming a similar program in Salt Lake City plus the impact on circulating traffic, it is not impossible to anticipate a 10 percent reduction in travel with a corresponding reduction in vehicle emissions.

The cost of the strategy is, however, relatively high. In Los Angeles, the parking structures alone were estimated to cost $37.5 million (three garages and one surface lot).

## F. IMPROVED MASS TRANSIT

### 1. General

This strategy is aimed at increasing mass transit ridership. Improvements can be either technical or operational. The performance and attractiveness of the vehicle itself can be improved to help encourage ridership. Secondly, the transit service can be expanded, thus providing better service. Improved transit service may not always reduce vehicular travel unless additional measures (restraints) are introduced to discourage vehicular travel. Conversely, improved mass transit is essential to successful implementation of other strategies such as peripheral parking.

A recent study of transit by Alan M. Voorhees and Associates illustrates the decline in transit ridership in Salt Lake City. Since 1955 there has been a steady decline in transit usage in Salt Lake City. In 1970 there were 3.72 million annual revenue passengers compared to 13.2 million in 1955. The trend has been typical of the declining transit usage throughout the entire country.

The Voorhees study described three alternative transit plans ranging from a low 1980 usage estimate of 2.8 million to a high of 6.1 million. Obviously, the low estimate plans for a slight decline in usage while the high figure represents a significant increase in usage by 1980.

The three alternate plans are described as follows:

- Alternative 1 is a continuation of the trend in recent years to reduce service (routes and frequencies) and to defer the replacement of equipment. This action is intended to keep the cost of operating the system in balance with revenues (which are on the decrease owing to losses in ridership).

- Alternative 2 involves the maintenance of the service at its present level, with only minimal upgrading of equipment and expansion of routes and services. An objective might be the preservation of present ridership. Analysis described in the previous section indicates that this might be attainable.

- Alternative 3 requires a commitment to the general expansion of routes and services that includes extension of routes into suburban areas, computer express routes using freeways, and an increase in the hours of operation and the frequency of service.

This concept of improved mass transit as described herein differs from that described in the peripheral parking program in three ways:

(1) It envisions maximum coverage of transit outside of the CBD, thereby reducing automobile trips downtown

(2) It does not necessarily require peripheral parking

(3) It envisions express transit service from major trip generators in outlying areas

Peripheral parking and mass transit, however, may be combined and incorporated in one expanded transit program with increased benefits.

Mass transit programs, to be effective in reducing automobile travel, must also incorporate the concepts of parking controls and pricing within the downtown area. In other words, the convenience and cost of transit travel to downtown Salt Lake City must compare favorably with the convenience and cost of travel by automobile. Present policies and programs aimed at increasing the parking supply and improving automobile access in downtown Salt Lake City tend to encourage use of private automobiles at the expense of transit. For transit to have a significant impact on travel in the downtown area, some type of controls or changes in policy will be necessary.

### 2. Impact on Vehicle Emissions

It is understood that the adopted plan anticipates approximately 5.5 million annual revenue passengers by 1980. In effect, this slight increase in usage above present levels represents a net reduction of approximately 3,280 vehicle trips per day, or less than 2 percent of the projected 1980 trip ends for the CBD (projected 1980 vehicle trip ends, CBD = 196,788 per day). Therefore, the impact of the adopted transit plan is relatively insignificant in terms of total vehicular travel.

## G. OTHER ALTERNATE STRATEGIES

### 1. Prohibit Traffic During Certain Periods of the Day and in Specified Areas

A priority travel list could be compiled based on travel needs and trip characteristics such as commuter, school, shopping, and business trips. Pollution levels would then be controlled through the elimination of a number of trips and trip types at critical times. The main problem is to establish a control network to insure that traffic flow is in conformance with the priority rule. Without electronic monitors, a large pool of manpower is required at critical checkpoints, which could increase the emission levels at those points by reducing traffic speed and increasing idling time.

This measure suggests a mandatory control of tripmaking and is not considered feasible from either a political or enforcement standpoint except during periods of emergency episodes.

### 2. Restrict Curb Parking

The elimination of curb parking spaces most often results from demand for additional loading zones, bus stops or driveways and is not aimed at reducing traffic volumes. Generally, the end result is an improvement of traffic flow and reduction of delays, which in turn reduces emission levels. This measure is successful only if the resulting improvement in roadway capacity does not attract sufficient additional traffic to offset the increase in operating efficiency.

### 3. Staggered Work Hours

Stop-and-go peak-hour traffic causes the highest vehicle emission levels. Traffic volumes are a function of travel demand and available roadway capacity at a given time. Travel demand can be reduced in the peak-hour if the need for travel in that period is reduced. One method of accomplishing this is through the introduction of staggered work hours; this has been studied and tested on a small scale in other cities. It is important to understand that staggered work hours merely relieve traffic congestion in a short peak period. The decrease in traffic volume during the peak generally is offset by the volume increase at periods adjacent to the peak periods. Though the total traffic volume over a period of time remains constant, the average speed will increase slightly, thereby reducing vehicle emissions.

Staggered work hours, however, may work to the detriment of a viable transit system which depends upon high demand levels of work trips during the peak periods to offset operating costs during off-peak hours. There may also be a negative effect on car pooling since fewer people travel to the same destination at the same time.

### 4. Car Pooling

This measure has many positive features: it maintains the flexibility and freedom of travel afforded by the automobile; it does not require additional capital improvements; it reduces congestion; it cuts down the individual's travel expense and it reduces emission. Car pooling is economically and functionally practical in the State of Utah, as it is elsewhere. No formal public or private organization is set up to implement such a scheme due to the legal uncertainties involved such as the liabilities of the driver in case of accident or theft. However, there are indications that car pooling, if fully explored and properly administered, could produce fruitful results in reducing traffic volumes.

### 5. Reduction in Truck VMT

One control strategy which to date has not been fully explored is the possibility of reducing or eliminating truck travel in certain congested areas. In some ways, Salt Lake City is fortunate since interstate highways (freeways) bypass a good portion of truck traffic around the CBD. However, these freeways are immediately adjacent to the CBD and therefore affect the air quality.

Truck travel, including panel and pick-up trucks, approximates 14.8 percent of the daily travel in Salt Lake. Hourly variations in truck travel in Salt Lake generally match those found in other cities throughout the United States.*

The ICC regulates interstate truck traffic and therefore represents a method of control over a portion of truck traffic in Salt Lake City.

---

*Motor trucks in the Metropolis, Wilbur Smith and Associates, August 1969, p. 52.

The scope of this study did not permit an investigation of the impact of truck traffic on vehicle emissions. Therefore, it is recommended that additional study be given to the full impact of heavy duty trucks on air pollution in Salt Lake City. This study should investigate the location of truck terminals, truck routes, and hours of operation to determine whether special controls of truck traffic, specifically heavy duty interstate freight, can help reduce vehicle emissions.

## IV. SELECTION OF TRANSPORTATION CONTROLS AND ESTIMATE OF AIR QUALITY IMPACT

### A. RECOMMENDED STRATEGY

On the basis of the previous analysis, and consideration of implementation obstacles to various controls (Section V), traffic flow improvements is selected as the recommended strategy. It appears that Salt Lake City can reach air quality standards with the installation of an efficient computerized traffic signal system (TOPICS Improvement Project No. 1). Although the benefits of such a signal system may prove to be only short range, approximately five years or less, this covers the period of particular concern since air quality projections indicate that standards will be met by 1979 by means of the Federal Motor Vehicle Control Program alone.

In addition to the computerized signal system, there are a number of smaller TOPICS improvement projects which could produce smaller reduction in vehicle emissions. These include, primarily, the High Priority Projects described in the Salt Lake City TOPICS Study.

It should be mentioned that Salt Lake City currently is experiencing an $NO_x$ problem, having reported an annual average concentration of 0.07 ppm in 1970, and that strategies designed to alleviate excessive emissions of CO by increasing vehicle speed may result in increased $NO_x$ levels. Although the recommended traffic flow improvements are not expected to play a significant part in the overall $NO_x$ problem, it is recommended that several of the other strategies discussed in Section III be considered as "back-up" measures. Any of these strategies could be employed at a later date should additional controls prove necessary. Specifically, planning for mass transit improvements should continue, and the role of the automobile - in particular parking in the downtown area - should be carefully re-evaluated.

Section VI discusses the suggested methods of surveillance which should be implemented to verify the impact of the computerized traffic control system.

## B. AIR QUALITY IMPACT

Vehicular CO emission densities for 1977 were calculated for the Core Area zones that would be affected by the proposed Computer Central Signal Control System by assuming a 25 to 30 percent increase in vehicular speeds as postulated in Section III-D-2. Figure IV-1 shows the 8-hour emission densities that resulted.

The emission densities for the three critical zones (C, H, and I) are all below the maximum acceptable value of 3996 kg/8-hr/mi$^2$ estimated from the 1971 data. However, the emission densities for Zone C and Zone H still exceed somewhat the maximum acceptable value of 3128 estimated from the 1970 data. Table IV-1 summarizes the emission density and air quality estimates for the critical zones. The best estimate of air quality is judged to be the average of the two quasi-independent estimates. On this basis, CO concentrations should meet the ambient standards in all three zones.

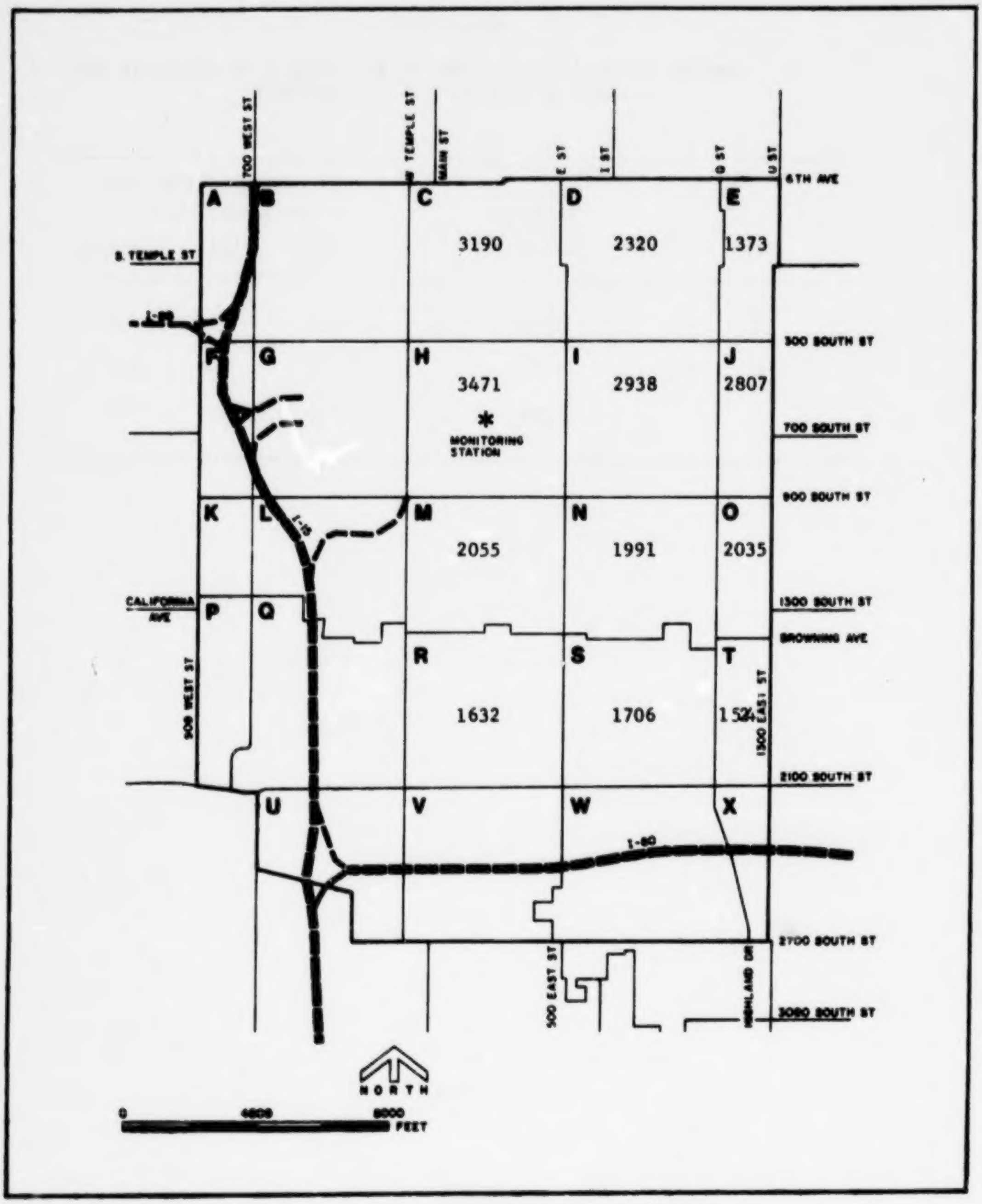

700 WEST ST
W TEMPLE ST
MAIN ST
E ST
I ST
O ST
U ST
6TH AVE
S. TEMPLE ST
I-80
300 SOUTH ST
700 SOUTH ST
900 SOUTH ST
CALIFORNIA AVE
1300 SOUTH ST
BROWNING AVE
900 WEST ST
1300 EAST ST
2100 SOUTH ST
I-15
I-80
2700 SOUTH ST
500 EAST ST
HIGHLAND DR
3000 SOUTH ST
A
B
C
3190
D
2320
E
1373
F
G
H
3471
MONITORING STATION
I
2938
J
2807
K
L
M
2055
N
1991
O
2035
P
Q
R
1632
S
1706
T
1524
U
V
W
X
NORTH
0
4000
8000
FEET

**Figure IV-1. CO emission densities (kg/8-hr/mi$^2$) for 1977 based on Traffic Flow Improvement.**

## TABLE IV-1

## SUMMARY OF EMISSION DENSITY AND AIR QUALITY ESTIMATES IN 1977 BASED ON TRAFFIC FLOW IMPROVEMENTS

| Zone | Emission Density (kg/8-hr/mi$^2$) | CO Concentration (ppm) Reference Year 1970 | 1971 | Average |
|---|---|---|---|---|
| C | 3190 | 9.2 | 7.3 | 8.2 |
| H | 3471 | 9.9 | 7.9 | 8.9 |
| I | 2938 | 8.5 | 6.7 | 7.6 |

## V. OBSTACLES TO IMPLEMENTATION OF SELECTED CONTROLS

### A. INTRODUCTION AND SUMMARY

This section presents an assessment of the potential obstacles to the implementation of several proposed transportation strategies generated to control excessive automotive exhaust emissions in downtown Salt Lake. Initial analyses of air quality data and emissions projections to 1977 indicate that, taking other anticipated technological changes into account, Salt Lake City (SLC) and the State of Utah will need to reduce emissions (principally carbon monoxide) in the study area by approximately 8 percent by 1977 in order to meet federal air quality standards.

Documentation and reporting on implementation barriers for Salt Lake City has had to be general due to the generality of the transportation control strategies. More importantly, the strategies have not been reviewed adequately by the local air pollution officials, transportation agencies, and other relevant actors prior to the end of the scheduled reporting period and thus our assessment of obstacles to implementation is necessarily brief. Evaluation of the local planning context and selected political and economic patterns, coupled with the impressionistic responses of certain key figures in Salt Lake, have been the major information inputs.

Our findings -- that a concentrated effort to improve the traffic flow in the SLC central business district is the most feasible strategy for achievement of federal air quality goals -- are, therefore, preliminary. Utah State and local officials should not be prejudiced in the selection of other transportation control strategies deemed effective by them, in view of the fact that they have had limited opportunity to respond to those reviewed here.

## B. METHODOLOGY

Assessment of the obstacles to implementation of transportation control strategies was primarily based upon open-ended interviews with knowledgeable individuals within Utah State government and the Salt Lake City community, an evaluation of a State level meeting of air pollution and transportation staff and EPA representatives (held October 31, 1972), and participation in a joint sub-committee (Transportation and Environment) meeting of the Wasatch Front Regional Council, the authorized regional planning body for the Salt Lake area. During the interviews the attached questionnaire (Appendix D) was utilized as an interview guide. A list of interviewees appears as Appendix E.

Background information about the problem was drawn from several previous studies and from an examination of the legislative authority and administrative regulations of the Utah State Air Conservation Committee. Note was taken of the history of on-going hearings respecting the Utah Air Implementation Plan under 42 CFR Part 420.5, concerned with stationary pollution control planning. Studies reviewed included the Salt Lake City TOPICS report, the Utah Process Report on Statewide Planning Problems, and a comprehensive study of the mass transit system serving SLC.

## C. ASSESSMENT OF PROPOSED TRANSPORTATION CONTROL STRATEGIES

### 1. Recommended Strategy: (Traffic Flow Improvements)

For a variety of reasons, this strategy appears to be both acceptable and feasible along each of the dimensions studied. Assuming that this strategy will effectively reduce emissions by the required amount as indicated, adoption of this strategy should prove acceptable to the SLC business community, the driving public, and public officials in the State of Utah, and consistent with current downtown development patterns.

Driver acceptance can be readily predicted, in part, because traffic flow improvements would enhance the Utahn's well entrenched preference for moving freely from place to place in his automobile. It was consistently and convincingly reported that Utahns would fiercely oppose any transportation control strategy which would regulate or restrain their automotive mobility. The street geometry of Salt Lake City and an aggressive campaign by local business interests to make it attractive to drive into the downtown area both cooperate to reinforce the Utahn's loyalty to their automobiles.

It is said that when Brigham Young first settled the Salt Lake area, he sensibly marked the street widths by the area needed to turn a team of horses and covered wagon full circle. As a result, the principal street arteries in the downtown area are among the widest in the nation. Many streets in the study area are a full six traffic lanes wide. Even with the utilization of some curbside parking restrictions now in effect at the peak hours, the capacity of downtown SLC streets to absorb traffic appears far from saturated.

As reported in the recently published TOPICS report, the SLC central business district presently serves as the Inter-mountain Region's largest shopping concentration, plays an expanding role in supporting recreation and convention activities, and, by every economic indicator, should continue to prosper in the years ahead. The central business district of SLC was found to be "the single largest trip generator in the Salt Lake Valley."

The central business district merchants are in open competition with the expanding suburban shopping center complexes which threaten their documented supremacy. At least five new privately owned and financed parking garages are under construction in the central business district at the present time, several of these sponsored by large department stores. A recent parking survey conducted by the Mayor's Ad Hoc Parking Committee has called for more off-street parking in selected areas in the central city even though the municipally unregulated parking rates in prime locations are now as low as $13-15 per month. The major department stores recently rejected a proposal to validate transit authority bus tickets presented by their customers. Taken together, these facts suggest that a program of traffic flow improvement is most suitably geared to SLC where reliance upon the preferred and most attractive transportation mode seems inevitable.

This strategy presents the State and the Salt Lake community with the least imposing institutional and inter-governmental planning problem. The TOPICS report, calling for a centralized computer signal control system has been completed and approved by the relevant public agencies, and current plans call for development of an implementation plan and earmarking of City funds to cover project costs. While the report's focus was traffic congestion and safety, its primary recommendations appear to be consistent with air quality objectives. Since the recommended improvement program concentrates upon downtown Salt Lake, the City of Salt Lake and the State Highway Department appear to be the only primary agencies charged with and possessing the requisite responsibility for executing the plan. Thus, the task of securing multi-governmental executive and administrative approval of large scale projects can (for the most part) be avoided. Some discussion has already preceded the present emissions question which indicates that these two agencies have considered their need to cooperate on the TOPICS venture. The State Air Conservation Committee could verify the sufficiency of the current TOPICS plan as far as the reduction of harmful emissions is concerned, recommend needed modifications in the plan if indicated, and monitor scheduling and implementation of the computerized signal program.

The preliminary cost estimate for the proposed signal system is under $500,000, with 75 percent of this amount available from federal

TOPICS funds. The availability of local matching funds is dependent upon future SLC budgetary decision-making, but local priorities for transportation services appear to support the likelihood that the necessary funds will be allocated for this project.

No legislation is required to authorize this strategy and no legal barriers appear to pose an impediment to its implementation.

Should Salt Lake City choose to initiate a traffic flow improvement program, at least five separate agencies should be expected to approve this selection: The Air Conservation Committee, the State Department of Social Services, Division of Health, the State Highway Commission, the Salt Lake City Council, and the Wasatch Front Regional Council. Development of an implementation plan without the express approval of at least these agencies would not be productive in reducing the air pollution problem in the study area.

## 2. Other Candidate Strategies

### a. Peripheral Parking and Car Pooling

While the assessment of this strategy is dependent upon our evaluation of the mass transportation question dealt with immediately below, one interesting variation of a peripheral parking/car pooling strategy deserves separate mention. As a result of the Utah State Highway Department's observation that some commuters were voluntarily parking their cars outside the city proper along the inter-state highway and pooling rides into Salt Lake City, a pilot project supportive of this behavior has been recommended to the State Highway Commission. It is proposed that funds from the State Gas Tax Fund be used to pave and surface a commuter parking area for the convenience of these motorists in the immediate future. Consideration has been given to acquiring extended rights of way for this purpose should the pilot project be deemed successful in attracting other users.

This project evidences some margin of voluntary cooperation on the part of the driving public but, more importantly, signifies Departmental responsiveness and sensitivity toward meeting the transportation preferences of Utah citizens. Further, the State Highway staff have also demonstrated foresight and competence in their support for innovative transportation services.

A campaign to stimulate increased car pooling could be waged on a fairly low budget by encourating the participation of the media and advertising councils, and through the large employing organizations referred to below.

The disadvantages of testing such a strategy would be the extended time which would be required in order to test the effectiveness of the campaign and its potential effect on the air pollution problem. If it were not successful, valuable time may be lost in meeting 1977 air quality goals.

b. Staggered Work Hours

This strategy requires further study and a poll of central area employers to test their receptivity to this solution to the air quality problem. At the outset, however, the conditions for adopting this strategy appear reasonably good. The principal employers in the central city area are represented by a few large organizations -- the government, the Mormon Church, and several large retail stores -- who have the capacity to dramatically alter peak hour traffic volumes by changes in their work schedules. In none of these areas is strong union organization which might oppose this strategy present. While it is difficult to reach agreement in altering work schedules and habits, the key decision group in SLC would be concentrated and, presumably, fairly cooperative. Further examination of the multiple motives which underlie trip generation seems indicated, however, since a substantial segment of SLC traffic may be attributed to other than work-related travel.

The direct cost of this strategy is negligible and no apparent legal bar was encountered in testing the feasibility of this strategy.

### c. Improved Mass Transit

The case for the development of some form of region-wide mass transportation system serving the entire Wasatch Front corridor between Ogden and Provo is compelling, and in the long run, probably inevitable. For the short term, however, the political, institutional, and financial obstacles to implementation of this proposed strategy appear overwhelming. In view of the fact that financing and operation of an expanded mass transportation system serving the SLC area could not be accomplished within five years, this strategy may be discarded as infeasible. Moreover, even if a crash program could be mounted for this purpose, analysis of source materials and projections indicate that the impact upon total vehicular travel and automobile circulation in the central business district would be insignificant.

SLC is currently served by a large and recently established public transit authority which operates a bus service and by a smaller privately owned bus company. Operation of the Transit Authority bus system is subsidized by the local governments where service routes are maintained according to a prescribed formula based upon ridership experience in these jurisdictions. For the past twenty years, ridership has steadily declined, services have been curtailed, and the financial future of the public system appears uncertain. It was reported that the anchor County of Salt Lake plans to withdraw its share of the subsidy for the transit system, forcing the Transit Authority to seek State support for continued operation of the system. Due to statutory limitations upon the bonding authority of the Transit Authority, it may be necessary to consider a one-half cent increase in the sales tax in Salt Lake County to generate the needed subsidy, comething the legislature may be unwilling to do in view of the cash reserves now on hand at the State level.

The State legislature picture will be further complicated by the anticipated introduction of a bill calling for the establishment of a comprehensive state-wide transportation agency, which would coordinate mass transit planning (and other transportation activities) and perhaps supersede the Utah Transit Authority altogether. Overall, the future direction of mass transportation and the governance of transportation instrumentalities in the State will be unsettled while the political debate and decision process takes its course.

### d. Prohibitions on Traffic and Restricted Curb Parking

In addition to the fact that all respondents indicated that Utahns would find vehicular restraints unacceptable, this strategy appears infeasible because it could not be coupled with the development of alternative transportation modes in the foreseeable future.

Retail establishments and downtown merchants could not reasonably be expected to support a strategy which runs counter to the substantial investment they are currently making in increasing automobile accessibility to downtown streets. While some limited increase in curbside restrictions would probably be found acceptable to both drivers and the business community in the interest of relieving congestion at peak hours, establishment of major vehicle-free zones does not seem likely.

In evaluating the acceptability of traffic restraints of any kind to either public officials or to the public in general, it is significant that several respondents observed that auto congestion is probably not perceived to be a major SLC problem and that air pollution, while conceded to be at least a problem of some dimension, has been identified in the public mind with the visible emissions from the nearby Kennecott Copper smelting plant, and not with automobile traffic. Some respondents believed that an effective public education campaign would probably be an essential component of any strategy which was directed at altering or restraining driving habits in the Salt Lake area.

### e. Rejected Strategy: Motor Vehicle Inspection and Retrofit

The opinion of nearly all respondents concerning this strategy was that it would be found unacceptable by the driving public in the State of Utah and for this reason, could not be expected to be vigorously advocated by public figures in the near future. Unverified statements of several respondents indicated that "smog control devices" were once previously proposed but convincingly defeated in the State Legislature. It was openly reported that it is not uncommon practice in Utah for drivers to "modify" factory installed pollution control devices on their late model cars by disconnecting equipment in the interest of improved performance.

Secondary reasons advanced against the notion of motor vehicle inspection and retrofit were the direct costs which had to be absorbed by the auto owner which were prohibitive, the burdening of those least able to pay the cost of retrofit (old car owners assumed to be the poor or near-poor), and the dwindling number of pre-1968 automobiles represented in the Utah auto pool as each year passed, rendered this strategy ineffective as far as controlling pollution if retrofit is limited to that age group. A persuasive argument was made by one State air quality official that the cost of the initial capitalization for equipment and training of such a program would be difficult to justify if, by 1981, inspection equipment and trained personnel would not be needed to control emissions.

In view of the widespread and strongly held negative attitudes about this strategy, examination of economic, legal and institutional factors bearing upon implementation of this proposed strategy was not pursued.

## VI. SURVEILLANCE REVIEW PROCESS

### A. TRAFFIC SURVEILLANCE METHODS

There are basically two traffic parameters which should be watched closely to verify the success of any transportation control strategy. These are:

- traffic volumes (ADT and hourly volumes)
- average operating speeds.

Estimates of 1977 volumes and speeds are provided in this report to serve as a check (see Table II-18).

If the signal control system is effective, the peak hour operating speeds will be increased to an average of 19 miles per hour within the CBD (present average - 15 mph).

Traffic volumes are expected to increase approximately 3 percent annually in the CBD. Appendix A contains traffic growth estimates by zone. Should either of these assumptions prove incorrect, there could be an increase in vehicle emissions. Therefore, in addition to a continual check on the air pollution level, both the city and state should maintain continuous checks of vehicle traffic volumes and speeds, especially within the CBD.

At present, both the City Traffic Engineering Department and the Utah State Department of Highways maintain records on traffic volumes and speeds. These should be continued and expanded to provide greater coverage in the CBD.

A systematic method of calculating VMT by vehicle type, road class and speed for the designated zones or sectors should be developed and correlated with the results obtained from the air pollution monitoring station to verify the significant changes as they occur annually. If the results indicate a lack of progress in reducing vehicle emissions, additional transportation control strategies can then be implemented by 1977.

### 1. Estimated Traffic Growth

Table VI-1 presents in summary the total 1971 and 1977 estimates of daily vehicle miles of travel for the core area defined in Figure II-8 . These figures provide a means for comparing the actual traffic growth with the projected traffic grwoth estimated in this report.

It should be noted that a freeway is currently under construction which will loop around the city on the south and west. It will connect with I-80 on the east, I-15 on the south, and I-80 on the west. This freeway, when completed and open to traffic, should tend to

TABLE VI-1

DAILY VEHICLE MILES OF TRAVEL 1971-1972
(Core Area Totals)

| | 1971 DVMT (000) | 1977 DVMT (000) | Increase | Percent |
|---|---|---|---|---|
| Streets | 1585.0 | 1869.3 | 284.3 | 17.9 |
| Freeways | 482.9 | 583.9 | 101.0 | 20.9 |
| TOTAL | 2067.9 | 2453.2 | 385.3 | 18.6 |

reduce travel on several heavily traveled streets and freeways, especially I-80 and Highland Drive, south of the CBD. It is assumed that the entire project, as planned, will not be completed by 1977. Therefore, the full impact of this planned facility has not been included in the 1977 estimate of travel shown below. Traffic estimates for streets and freeways directly affected by this facility must be watched closely and adjusted where necessary, to reflect actual traffic flow patterns when established.

### 2. Estimated Speeds

Estimates of existing operating speeds for the core area, obtained primarily from speed studies conducted annually by the Salt Lake Area Transportation Study, are presented in Table VI-2. The speeds are averages for several streets studied and include stops and delays. Although these studies are considered accurate for the streets covered, more streets should be studied to further define and verify these average speeds by time of day, type of vehicle, and sector.

It is recommended that the existing speed studies currently being conducted be expanded to provide a more accurate and systematic

TABLE VI-2

ESTIMATED SPEEDS 1971-1972
(Core Area Only)

| | 1971 | | 1977 | |
|---|---|---|---|---|
| | Peak (mph) | Off-Peak (mph) | Peak (mph) | Off-Peak (mph) |
| Streets | 15 | 22 | 15(19) | 22 |
| Freeways | 50 | 58 | 50 | 58 |

(19) Estimated speed on streets affected by computerized traffic signal system (recommended transportation control strategy).

basis for verifying the actual speed improvements achieved by the computerized traffic signal system. As a minimum, a thorough "before and after" speed study should be performed on all streets which will likely be affected by the signal system.

## B. AIR QUALITY SURVEILLANCE

The combined effectiveness of the Federal Motor Vehicle Control Program and any transportation control measures that may be implemented in reducing ambient CO concentrations to acceptable levels ultimately must be judged by air quality measurements. Figure II-8 shows that the Salt Lake City monitoring station is currently located within the region of maximum emissions. It is also located within the area being considered for the Computer Central Signal Control System. The monitor can, therefore, provide the necessary measurements by which the success of the emissions control program can be evaluated.

The curves presented in Figure VI-1 show the decrease in ambient concentrations expected in Zone H through 1977 as a result of the Federal Motor Vehicle Control Program alone, and as a result of the federal program and the traffic flow improvement plan.

Because of year-to-year variations in meteorological and other controlling factors, actual observations are expected to show considerable scatter about the predicted curves. Some idea of the possible magnitude of this scatter can be gained by comparing the second highest 8-hour concentration observed in 1971 (17 ppm) with that predicted by the 1970 based curve in Figure VI-1a (21.5 ppm).

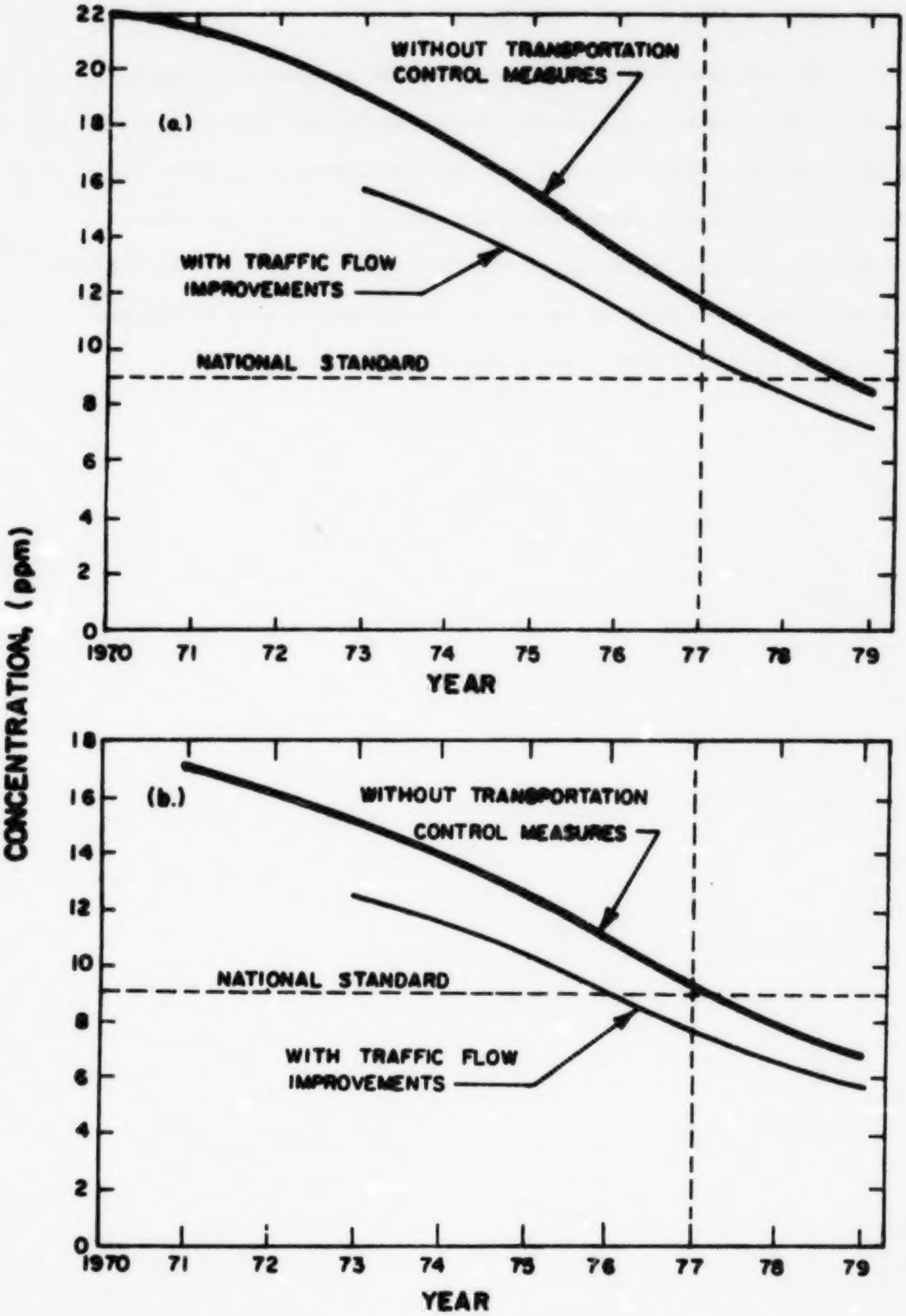


**Figure VI-1.** Projected 8-hour CO concentrations based on 1970 data (above) and 1971 data (below).

## C. SURVEILLANCE REVIEW MILESTONES

The computerized traffic signal system can easily be implemented by 1977. Given authorization to proceed by mid-1973, the plans and specifications should be completed in approximately one year. Actual construction and installation may require another two years with actual operation beginning in mid-1976. Full benefit of the signal system should be realized by 1977. Surveillance review milestones covering the period 1972-1977 are given in Figure VI-2.

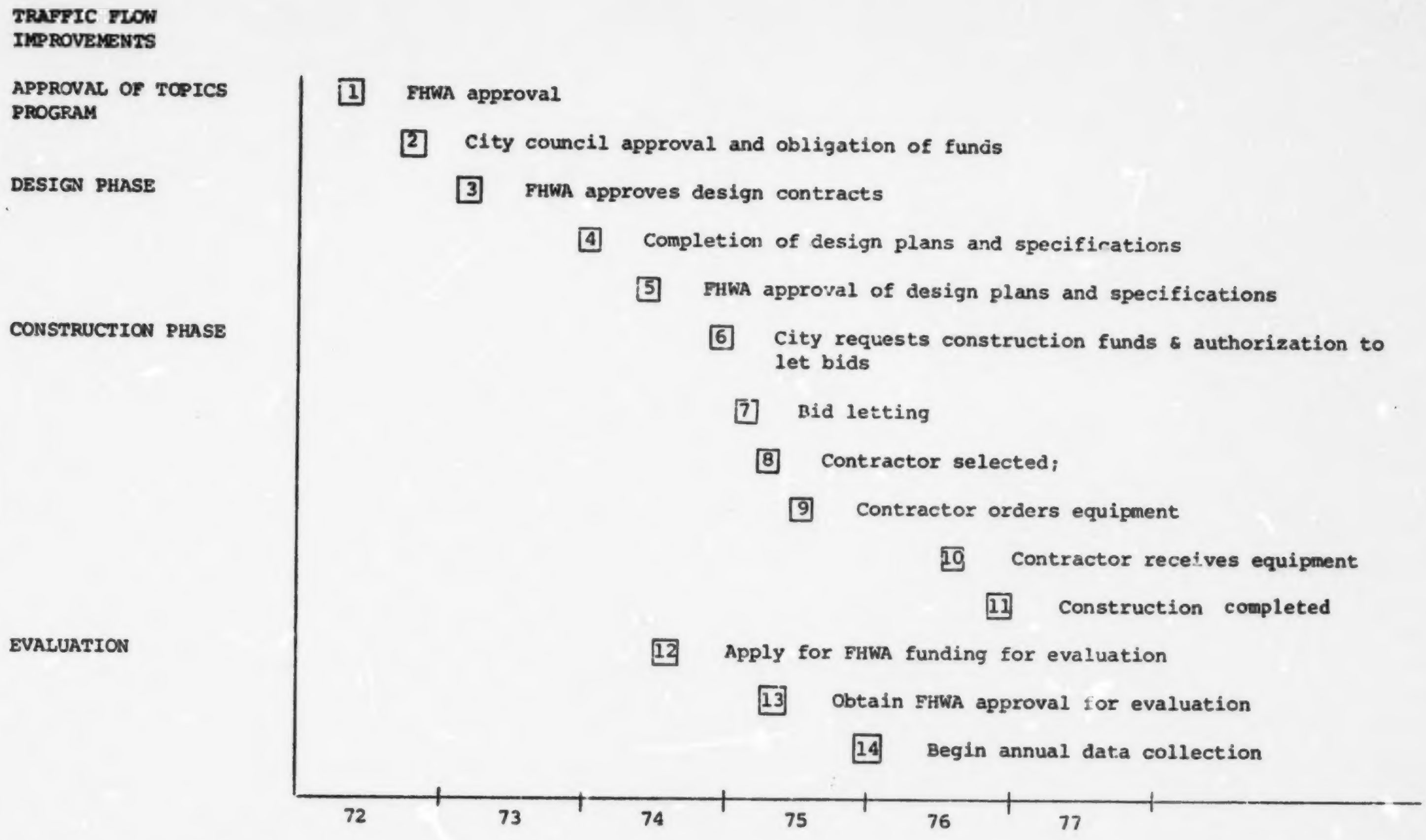


Figure VI-2. Surveillance review milestones; Salt Lake City.

# APPENDIX A

## 1971-1977 VEHICLE MILES OF TRAVEL

## APPENDIX A

## 1971-1977 VEHICLE MILES OF TRAVEL, SALT LAKE CITY AREA

| SUB-AREA | 1971 DAILY VEHICLE MILES (000) | | EXPANSION FACTOR | 1977 DAILY VEHICLE MILES (000) | |
|---|---|---|---|---|---|
| | Streets | Frwys. | | Streets | Frwys. |
| 1 | 7.9 | | 1.25 | 9.9 | |
| 2 | 4.9 | 13.5 | 1.25 | 6.1 | 16.9 |
| 3 | 3.8 | | 1.20 | 4.6 | |
| 4 | 10.9 | | 1.20 | 13.1 | |
| 5 | 8.8 | | 1.15 | 10.1 | |
| 6 | 8.5 | | 1.15 | 9.8 | |
| 7 | 9.5 | | 1.15 | 10.9 | |
| 8 | 10.7 | | 1.15 | 12.3 | |
| 9 | 8.6 | | 1.15 | 9.9 | |
| 10 | 5.2 | | 1.15 | 6.0 | |
| 11 | 4.7 | | 1.15 | 5.4 | |
| 12 | 12.5 | 9.3 | 1.25 | 15.6 | 11.6 |
| 13 | 9.1 | 5.9 | 1.20 | 10.9 | 7.1 |
| 14 | 9.5 | | 1.20 | 11.4 | |
| 15 | 19.3 | | 1.20 | 23.2 | |
| 16 | 22.8 | | 1.20 | 27.4 | |
| 17 | 21.0 | | 1.20 | 25.2 | |
| 18 | 15.7 | | 1.20 | 18.8 | |
| 19 | 15.7 | | 1.18 | 18.5 | |
| 20 | 10.9 | | 1.18 | 12.9 | |
| 21 | 11.1 | | 1.18 | 13.1 | |
| 22 | 6.4 | | 1.18 | 7.6 | |
| 23 | 8.0 | 17.6 | 1.25 | 10.0 | 22.0 |
| 24 | 7.8 | | 1.20 | 9.4 | |
| 25 | 8.1 | | 1.15 | 9.3 | |
| 26 | 16.6 | | 1.18 | 19.6 | |
| 27 | 20.6 | | 1.18 | 24.3 | |
| 28 | 22.5 | | 1.18 | 26.6 | |
| 29 | 14.2 | | 1.18 | 16.8 | |
| 30 | 17.0 | | 1.15 | 19.6 | |
| 31 | 19.4 | | 1.12 | 21.7 | |
| 32 | 16.8 | | 1.15 | 19.3 | |
| 33 | 11.4 | | 1.18 | 13.5 | |
| 34 | 7.1 | 17.1 | 1.25 | 8.9 | 21.4 |
| 35 | 4.7 | | 1.20 | 5.6 | |
| 36 | 5.9 | | 1.15 | 6.8 | |
| 37 | 17.6 | | 1.18 | 20.8 | |
| 38 | 22.2 | | 1.18 | 26.2 | |
| 39 | 23.7 | | 1.18 | 28.0 | |
| 40 | 17.5 | | 1.18 | 20.7 | |
| 41 | 18.5 | | 1.15 | 21.3 | |

| SUB-AREA | 1971 DAILY VEHICLE MILES (000) |  | EXPANSION FACTOR | 1977 DAILY VEHICLE MILES (000) |  |
|---|---|---|---|---|---|
|  | Streets | Frwys. |  | Streets | Frwys. |
| 42 | 24.8 |  | 1.12 | 27.8 |  |
| 43 | 14.1 |  | 1.15 | 16.2 |  |
| 44 | 13.6 |  | 1.18 | 16.0 |  |
| 45 | 4.8 | 25.4 | 1.25 | 6.0 | 31.8 |
| 46 | 7.2 |  | 1.20 | 8.6 |  |
| 47 | 16.7 |  | 1.15 | 19.2 |  |
| 48 | 22.2 |  | 1.18 | 26.2 |  |
| 49 | 23.8 |  | 1.18 | 28.1 |  |
| 50 | 18.9 |  | 1.18 | 22.3 |  |
| 51 | 12.1 |  | 1.18 | 14.3 |  |
| 52 | 12.6 |  | 1.15 | 14.5 |  |
| 53 | 19.1 |  | 1.12 | 21.4 |  |
| 54 | 13.7 |  | 1.12 | 15.3 |  |
| 55 | 17.4 |  | 1.18 | 20.5 |  |
| 56 | 9.8 |  | 1.25 | 12.3 |  |
| 57 | 7.1 | 26.0 | 1.20 | 8.5 | 31.2 |
| 58 | 7.0 |  | 1.15 | 8.1 |  |
| 59 | 3.3 |  | 1.18 | 3.9 |  |
| 60 | 16.8 |  | 1.18 | 19.8 |  |
| 61 | 17.4 |  | 1.18 | 20.5 |  |
| 62 | 10.4 |  | 1.18 | 12.3 |  |
| 63 | 11.3 |  | 1.15 | 13.0 |  |
| 64 | 19.5 |  | 1.12 | 21.8 |  |
| 65 | 9.8 |  | 1.12 | 11.0 |  |
| 66 | 12.5 |  | 1.18 | 14.8 |  |
| 67 | 7.3 |  | 1.25 | 9.1 |  |
| 68 | 3.2 | 32.2 | 1.20 | 3.8 | 38.6 |
| 69 | 5.6 | 5.4 | 1.15 | 6.4 | 6.2 |
| 70 | 8.3 | 5.7 | 1.16 | 9.6 | 6.6 |
| 71 | 15.8 |  | 1.16 | 18.3 |  |
| 72 | 15.9 |  | 1.16 | 18.4 |  |
| 73 | 7.0 |  | 1.16 | 8.1 |  |
| 74 | 10.2 |  | 1.16 | 11.8 |  |
| 75 | 16.1 |  | 1.16 | 18.7 |  |
| 76 | 9.7 |  | 1.12 | 10.9 |  |
| 77 | 8.8 |  | 1.18 | 10.4 |  |
| 78 | 5.3 |  | 1.25 | 6.6 |  |
| 79 | 1.0 |  | 1.20 | 1.2 |  |
| 80 | 1.7 | 19.9 | 1.15 | 2.0 | 22.9 |
| 81 | 9.0 |  | 1.15 | 10.4 |  |
| 82 | 7.4 |  | 1.15 | 8.5 |  |

| SUB-AREA | 1971 DAILY VEHICLE MILES (000) |  | EXPANSION FACTOR | 1977 DAILY VEHICLE MILES (000) |  |
|---|---|---|---|---|---|
|  | Streets | Frwys. |  | Streets | Frwys. |
| 83 | 8.6 |  | 1.15 | 9.9 |  |
| 84 | 3.2 |  | 1.15 | 3.7 |  |
| 85 | 15.1 |  | 1.15 | 17.4 |  |
| 86 | 6.3 |  | 1.12 | 7.1 |  |
| 87 | 9.3 |  | 1.18 | 11.0 |  |
| 88 | 8.2 |  | 1.25 | 10.3 |  |
| 89 | 4.7 |  | 1.20 | 5.6 |  |
| 90 | 5.8 | 14.8 | 1.15 | 6.7 | 17.0 |
| 91 | 8.3 |  | 1.15 | 9.5 |  |
| 92 | 11.1 |  | 1.15 | 12.8 |  |
| 93 | 12.6 |  | 1.15 | 14.5 |  |
| 94 | 7.0 |  | 1.15 | 8.1 |  |
| 95 | 7.6 |  | 1.15 | 8.7 |  |
| 96 | 16.5 |  | 1.15 | 19.0 |  |
| 97 | 7.2 |  | 1.15 | 8.3 |  |
| 98 | 11.0 |  | 1.20 | 13.2 |  |
| 99 | 2.5 |  | 1.18 | 3.0 |  |
| 100 | 5.1 |  | 1.18 | 6.0 |  |
| 101 | 11.6 |  | 1.18 | 13.7 |  |
| 102 | 12.3 |  | 1.18 | 14.5 |  |
| 103 | 2.7 |  | 1.18 | 3.2 |  |
| 104 | 5.1 |  | 1.18 | 6.0 |  |
| 105 | 16.4 |  | 1.18 | 19.4 |  |
| 106 | 7.7 |  | 1.18 | 9.1 |  |
| 107 | 12.4 |  | 1.25 | 15.5 |  |
| 108 | 4.5 |  | 1.25 | 5.6 |  |
| 109 | 1.0 |  | 1.18 | 1.2 |  |
| 110 | 7.0 |  | 1.18 | 8.3 |  |
| 111 | 6.9 |  | 1.18 | 8.1 |  |
| 112 | 10.5 |  | 1.18 | 12.4 |  |
| 113 | 7.3 |  | 1.18 | 8.6 |  |
| 114 | 6.4 |  | 1.18 | 7.6 |  |
| 115 | 11.2 |  | 1.18 | 13.2 |  |
| 116 | 8.4 |  | 1.18 | 9.9 |  |
| 117 | 6.1 |  | 1.20 | 7.3 |  |
| 118 | 4.4 |  | 1.20 | 5.3 |  |
| 119 | 7.5 |  | 1.20 | 9.0 |  |
| 120 | 13.4 |  | 1.20 | 16.1 |  |
| 121 | 5.0 |  | 1.20 | 6.0 |  |
| 122 | 3.8 |  | 1.20 | 4.6 |  |
| 123 | 13.1 |  | 1.20 | 15.7 |  |

| SUB-AREA | 1971 DAILY VEHICLE MILES (000) Streets | 1971 DAILY VEHICLE MILES (000) Frwys. | EXPANSION FACTOR | 1977 DAILY VEHICLE MILES (000) Streets | 1977 DAILY VEHICLE MILES (000) Frwys. |
|---|---|---|---|---|---|
| 124 | 7.1 | | 1.20 | 8.5 | |
| 125 | 4.6 | | 1.20 | 5.5 | |
| 126 | 11.7 | | 1.20 | 14.0 | |
| 127 | 29.5 | | 1.20 | 35.4 | |
| 128 | 13.1 | | 1.20 | 15.7 | |
| 129 | 24.3 | | 1.20 | 29.2 | |
| 130 | 7.9 | 18.3 | 1.20 | 9.5 | 22.0 |
| 131 | 20.0 | 16.3 | 1.20 | 24.0 | 19.6 |
| 132 | 9.9 | 20.1 | 1.20 | 11.9 | 24.1 |
| 133 | 17.2 | 14.4 | 1.20 | 20.6 | 17.3 |
| 134 | 2.6 | 11.3 | 1.20 | 3.1 | 13.6 |
| 135 | 0.6 | 89.6 | 1.20 | 0.7 | 107.5 |
| 137 | 10.0 | | 1.20 | 12.0 | |
| 138 | 16.9 | | 1.20 | 20.3 | |
| 139 | 21.3 | | 1.20 | 25.6 | |
| 140 | 9.8 | | 1.20 | 11.8 | |
| 141 | 2.7 | 19.9 | 1.20 | 3.2 | 23.9 |
| 142 | 12.0 | 16.1 | 1.20 | 14.4 | 19.3 |
| 143 | 17.9 | 17.7 | 1.20 | 21.5 | 21.2 |
| 144 | 4.8 | 17.7 | 1.20 | 5.8 | 21.2 |
| 145 | 31.5 | | 1.20 | 37.8 | |
| 146 | 18.9 | | 1.35 | 25.5 | |
| 147 | 22.3 | | 1.30 | 29.0 | |
| 148 | 19.5 | 10.4 | 1.25 | 24.4 | 13.0 |
| 149 | 47.6 | 3.1 | 1.25 | 59.5 | 3.9 |
| 150 | 42.2 | 20.2 | 1.25 | 52.8 | 25.3 |
| 151 | 31.6 | | 1.25 | 39.5 | |
| 152 | 23.9 | | 1.15 | 27.5 | |
| 153 | 7.7 | | 1.25 | 9.6 | |
| 154 | 43.4 | | 1.30 | 56.4 | |
| 155 | 40.7 | | 1.225 | 49.9 | |
| 156 | 33.9 | | 1.225 | 41.5 | |
| 157 | 57.3 | 36.6 | 1.225 | 70.2 | 44.8 |
| 158 | 39.8 | | 1.40 | 55.7 | |
| 159 | 28.9 | | 1.35 | 39.0 | |
| 160 | 32.1 | 12.0 | 1.25 | 40.1 | 15.0 |
| 161 | 43.5 | | 1.25 | 54.4 | |
| 162 | 18.9 | | 1.20 | 22.7 | |
| 163 | 11.8 | | 1.20 | 14.2 | |
| 164 | 26.0 | 80.3 | 1.35 | 35.1 | 108.4 |

| SUB-AREA | 1971 DAILY VEHICLE MILES (000) |  | EXPANSION FACTOR | 1977 DAILY VEHICLE MILES (000) |  |
|---|---|---|---|---|---|
|  | Streets | Frwys. |  | Streets | Frwys. |
| 165 | 28.9 | 39.5 | 1.25 | 36.1 | 49.4 |
| 166 | 28.3 |  | 1.25 | 35.4 |  |
| 167 | 6.8 |  | 1.20 | 8.2 |  |
| 168 | 5.6 |  | 1.15 | 6.4 |  |
| 169 | 1.1 |  | 1.30 | 1.4 |  |
| 170 | 60.6 |  | 1.40 | 84.8 |  |
| 171 | 73.3 |  | 1.25 | 91.6 |  |
| 172 | 62.5 | 31.8 | 1.25 | 78.1 | 39.8 |
| 173 | 23.0 | 20.3 | 1.40 | 32.2 | 28.4 |
| 174 | 2.0 | 15.6 | 1.35 | 2.7 | 21.1 |
| 175 | 7.6 |  | 1.40 | 10.6 |  |
| 176 | 13.8 |  | 1.40 | 19.3 |  |
| 177 | 14.0 |  | 1.40 | 19.6 |  |
| 178 | 20.7 |  | 1.35 | 37.9 |  |
| 179 | 22.9 |  | 1.35 | 30.9 |  |
| 180 | 22.6 | 93.0 | 1.25 | 28.3 | 117.3 |
| 181 | 57.0 |  | 1.225 | 69.8 |  |
| 182 | 55.1 |  | 1.225 | 67.5 |  |
| 183 | 27.4 |  | 1.225 | 33.6 |  |
| 184 | 42.7 |  | 1.25 | 53.4 |  |
| 185 | 24.5 | 23.4 | 1.30 | 31.9 | 30.4 |
| 186 | 22.1 |  | 1.40 | 30.9 |  |
| 187 | 24.6 |  | 1.40 | 34.4 |  |
| 188 | 27.0 |  | 1.40 | 37.8 |  |
| 189 | 30.2 |  | 1.40 | 42.3 |  |
| 190 | 11.6 |  | 1.35 | 15.7 |  |
| 191 | 18.2 | 60.6 | 1.25 | 22.8 | 75.8 |
| 192 | 46.4 |  | 1.225 | 56.8 |  |
| 193 | 60.1 |  | 1.225 | 73.6 |  |
| 194 | 39.5 |  | 1.225 | 48.4 |  |
| 195 | 43.2 |  | 1.25 | 54.0 |  |
| 196 | 24.7 | 19.4 | 1.30 | 32.1 | 25.2 |
| 197 | 39.2 |  | 1.40 | 54.9 |  |
| 198 | 30.8 |  | 1.40 | 43.1 |  |
| 199 | 58.5 |  | 1.40 | 81.9 |  |
| 200 | 19.9 |  | 1.35 | 26.9 |  |
| 201 | 18.0 | 55.6 | 1.30 | 23.4 | 72.3 |
| 202 | 56.8 |  | 1.25 | 71.0 |  |
| 203 | 44.9 |  | 1.25 | 56.1 |  |
| 204 | 30.1 |  | 1.25 | 37.6 |  |
| 205 | 23.6 |  | 1.25 | 29.5 |  |

| SUB-AREA | 1971 DAILY VEHICLE MILES (000) |  | EXPANSION FACTOR | 1977 DAILY VEHICLE MILES (000) |  |
|---|---|---|---|---|---|
|  | Streets | Frwys. |  | Streets | Frwys. |
| 206 | 28.0 | 16.2 | 1.30 | 36.4 | 21.1 |
| 207 | 19.7 |  | 1.40 | 27.6 |  |
| 208 | 3.6 |  | 1.35 | 4.9 |  |
| 209 | 8.6 | 47.6 | 1.30 | 11.2 | 61.9 |
| 210 | 40.6 |  | 1.30 | 52.8 |  |
| 211 | 48.9 |  | 1.30 | 63.6 |  |
| 212 | 26.4 |  | 1.30 | 34.3 |  |
| 213 | 23.4 |  | 1.30 | 30.4 |  |
| *214 | 5.2 |  | 1.30 | 6.8 |  |
| *215 | 22.4 |  | 1.40 | 31.4 |  |
| *216 | 0.4 |  | 1.35 | 0.5 |  |
| 217 | 18.5 | 38.2 | 1.35 | 25.0 | 51.6 |
| 218 | 28.5 |  | 1.35 | 38.5 |  |
| 219 | 53.6 |  | 1.35 | 72.4 |  |
| 220 | 32.5 |  | 1.30 | 42.3 |  |
| 221 | 1.0 |  | 1.35 | 1.4 |  |
| *222 | 7.4 |  | 1.35 | 10.0 |  |
| 223 | 3.4 |  | 1.40 | 4.8 |  |
| *224 | 2.0 |  | 1.375 | 2.8 |  |
| *225 | 3.9 | 39.8 | 1.375 | 5.4 | 54.7 |
| *226 | 20.2 |  | 1.375 | 27.8 |  |
| *227 | 18.5 |  | 1.375 | 25.4 |  |
| *228 | 11.0 |  | 1.375 | 15.1 |  |
| *229 | 27.8 |  | 1.375 | 38.2 |  |
| *230 | 4.6 |  | 1.40 | 6.4 |  |
| 231 | 12.6 |  | 1.40 | 17.6 |  |
| 232 | 8.3 |  | 1.40 | 11.6 |  |
| 233 | 26.4 | 28.3 | 1.40 | 37.0 | 39.6 |
| 234 | 25.8 |  | 1.40 | 36.1 |  |
| 235 | 19.8 |  | 1.40 | 27.7 |  |
| 236 | 0.8 |  | 1.40 | 1.1 |  |
| 237 | 18.4 |  | 1.40 | 25.8 |  |
| 238 | 6.9 |  | 1.40 | 9.7 |  |
| 239 | 5.6 |  | 1.40 | 7.8 |  |

---

* Zones expected to have freeways by 1977 but with no estimate of freeway travel.

# APPENDIX B

# TRAVEL DENSITIES

## APPENDIX B

## TRAVEL DENSITIES, SALT LAKE CITY AREA

| ZONE | AREA (Sq.Mi.) | 1971 DAILY VEHICLE MILES (000) |  | 1971 VEHICLE MILES PER SQ. MI. (000) |  | 1977 DAILY VEHICLE MILES (000) |  | 1977 VEHICLE MILES PER SQ. MI. (000) |  |
|---|---|---|---|---|---|---|---|---|---|
|  |  | Streets | Frwys. | Streets | Frwys. | Streets | Frwys. | Streets | Frwys. |
| 1 | .09 | 7.9 |  | 87.8 |  | 9.9 |  | 110.0 |  |
| 2 | .09 | 4.9 | 13.5 | 54.4 | 150.0 | 6.1 | 16.9 | 78.8 | 187.8 |
| 3 | .09 | 3.8 |  | 42.2 |  | 4.6 |  | 51.1 |  |
| 4 | .09 | 10.9 |  | 121.1 |  | 13.1 |  | 145.6 |  |
| 5 | .09 | 8.8 |  | 97.8 |  | 10.1 |  | 112.2 |  |
| 6 | .07 | 8.5 |  | 121.4 |  | 9.8 |  | 140.0 |  |
| 7 | .10 | 9.5 |  | 95.0 |  | 10.9 |  | 109.0 |  |
| 8 | .10 | 10.7 |  | 107.0 |  | 12.3 |  | 123.0 |  |
| 9 | .10 | 8.6 |  | 86.0 |  | 9.9 |  | 99.0 |  |
| 10 | .10 | 5.2 |  | 52.0 |  | 6.0 |  | 60.0 |  |
| 11 | .10 | 4.2 |  | 42.0 |  | 5.4 |  | 54.0 |  |
| 12 | .09 | 12.5 | 9.3 | 138.8 | 103.3 | 15.6 | 11.6 | 173.3 | 128.9 |
| 13 | .09 | 9.1 | 5.9 | 101.1 | 65.6 | 10.9 | 7.1 | 121.1 | 78.9 |
| 14 | .09 | 9.5 |  | 105.6 |  | 11.4 |  | 126.7 |  |
| 15 | .09 | 19.3 |  | 214.4 |  | 23.2 |  | 257.8 |  |
| 16 | .09 | 22.8 |  | 253.3 |  | 27.4 |  | 304.4 |  |
| 17 | .07 | 21.0 |  | 300.0 |  | 25.2 |  | 360.0 |  |
| 18 | .09 | 15.7 |  | 174.4 |  | 18.8 |  | 208.9 |  |
| 19 | .09 | 15.7 |  | 174.4 |  | 18.5 |  | 205.6 |  |
| 20 | .09 | 10.9 |  | 121.1 |  | 12.9 |  | 143.3 |  |
| 21 | .09 | 11.1 |  | 123.3 |  | 13.1 |  | 145.6 |  |
| 22 | .09 | 6.4 |  | 71.1 |  | 7.6 |  | 84.4 |  |
| 23 | .09 | 8.0 | 17.6 | 88.9 | 195.6 | 10.0 | 22.0 | 111.1 | 244.4 |
| 24 | .09 | 7.8 |  | 86.7 |  | 9.4 |  | 104.4 |  |
| 25 | .09 | 8.1 |  | 90.0 |  | 9.3 |  | 103.3 |  |
| 26 | .09 | 16.6 |  | 184.4 |  | 19.6 |  | 217.7 |  |
| 27 | .09 | 20.6 |  | 228.9 |  | 24.3 |  | 270.0 |  |
| 28 | .09 | 22.5 |  | 250.0 |  | 26.6 |  | 295.6 |  |
| 29 | .09 | 14.2 |  | 157.8 |  | 16.8 |  | 186.7 |  |
| 30 | .09 | 17.0 |  | 188.9 |  | 19.6 |  | 217.8 |  |
| 31 | .09 | 19.4 |  | 215.6 |  | 21.7 |  | 241.1 |  |
| 32 | .09 | 16.8 |  | 186.7 |  | 19.3 |  | 214.4 |  |
| 33 | .09 | 11.4 |  | 126.7 |  | 13.5 |  | 150.0 |  |
| 34 | .09 | 7.1 | 17.1 | 78.9 | 190.0 | 8.9 | 21.4 | 98.9 | 237.8 |
| 35 | .09 | 4.7 |  | 52.2 |  | 5.6 |  | 62.2 |  |
| 36 | .09 | 5.9 |  | 65.6 |  | 6.8 |  | 75.6 |  |
| 37 | .09 | 17.6 |  | 195.6 |  | 20.8 |  | 231.1 |  |
| 38 | .09 | 22.2 |  | 246.7 |  | 26.2 |  | 291.1 |  |
| 39 | .09 | 23.7 |  | 263.3 |  | 28.0 |  | 311.1 |  |
| 40 | .09 | 17.5 |  | 194.4 |  | 20.7 |  | 230.0 |  |
| 41 | .09 | 18.5 |  | 205.6 |  | 21.3 |  | 236.7 |  |

| ZONE | AREA (Sq.Mi.) | 1971 DAILY VEHICLE MILES (000) |  | 1971 VEHICLE MILES PER SQ. MI. (000) |  | 1977 DAILY VEHICLE MILES (000) |  | 1977 VEHICLE MILES PER SQ. MI. (000) |  |
|---|---|---|---|---|---|---|---|---|---|
|  |  | Streets | Frwys. | Streets | Frwys. | Streets | Frwys. | Streets | Frwys. |
| 42 | .09 | 24.8 |  | 275.6 |  | 27.8 |  | 308.9 |  |
| 43 | .09 | 14.1 |  | 156.7 |  | 16.2 |  | 180.0 |  |
| 44 | .09 | 13.6 |  | 151.1 |  | 16.0 |  | 177.8 |  |
| 45 | .09 | 4.8 | 25.4 | 53.3 | 282.2 | 6.0 | 31.8 | 66.7 | 353.3 |
| 46 | .09 | 7.2 |  | 80.0 |  | 8.6 |  | 95.6 |  |
| 47 | .09 | 16.7 |  | 185.6 |  | 19.2 |  | 213.3 |  |
| 48 | .09 | 22.2 |  | 246.7 |  | 26.2 |  | 291.1 |  |
| 49 | .09 | 23.8 |  | 264.4 |  | 28.1 |  | 312.2 |  |
| 50 | .09 | 18.9 |  | 210.0 |  | 22.3 |  | 247.8 |  |
| 51 | .09 | 12.1 |  | 134.4 |  | 14.3 |  | 158.9 |  |
| 52 | .09 | 12.6 |  | 140.0 |  | 14.5 |  | 161.1 |  |
| 53 | .09 | 19.1 |  | 212.2 |  | 21.4 |  | 237.8 |  |
| 54 | .09 | 13.7 |  | 152.2 |  | 15.3 |  | 170.0 |  |
| 55 | .09 | 17.4 |  | 193.3 |  | 20.5 |  | 227.8 |  |
| 56 | .09 | 9.8 |  | 108.9 |  | 12.3 |  | 136.7 |  |
| 57 | .09 | 7.1 | 26.0 | 78.9 | 288.9 | 8.5 | 31.2 | 94.4 | 346.7 |
| 58 | .09 | 7.0 |  | 77.8 |  | 8.1 |  | 90.0 |  |
| 59 | .09 | 3.3 |  | 36.7 |  | 3.9 |  | 43.3 |  |
| 60 | .09 | 16.8 |  | 186.7 |  | 19.8 |  | 220.0 |  |
| 61 | .09 | 17.4 |  | 193.3 |  | 20.5 |  | 227.8 |  |
| 62 | .09 | 10.4 |  | 115.6 |  | 12.3 |  | 136.7 |  |
| 63 | .09 | 11.3 |  | 125.6 |  | 13.0 |  | 144.4 |  |
| 64 | .09 | 19.5 |  | 216.7 |  | 21.8 |  | 242.2 |  |
| 65 | .09 | 9.8 |  | 108.9 |  | 11.0 |  | 122.2 |  |
| 66 | .09 | 12.5 |  | 138.9 |  | 14.8 |  | 164.4 |  |
| 67 | .10 | 7.3 |  | 73.0 |  | 9.1 |  | 91.0 |  |
| 68 | .09 | 3.2 | 32.2 | 35.6 | 357.8 | 3.8 | 38.6 | 42.2 | 428.9 |
| 69 | .09 | 5.6 | 5.4 | 62.2 | 60.0 | 6.4 | 6.2 | 71.1 | 68.9 |
| 70 | .08 | 8.3 | 5.7 | 103.8 | 71.3 | 9.6 | 6.6 | 120.0 | 82.5 |
| 71 | .10 | 15.8 |  | 158.0 |  | 18.3 |  | 183.0 |  |
| 72 | .10 | 15.9 |  | 159.0 |  | 18.4 |  | 184.0 |  |
| 73 | .10 | 7.0 |  | 70.0 |  | 8.1 |  | 81.0 |  |
| 74 | .18 | 10.2 |  | 56.7 |  | 11.8 |  | 65.6 |  |
| 75 | .09 | 16.1 |  | 178.9 |  | 18.7 |  | 207.8 |  |
| 76 | .09 | 9.7 |  | 107.8 |  | 10.9 |  | 121.1 |  |
| 77 | .09 | 8.8 |  | 97.8 |  | 10.4 |  | 115.6 |  |
| 78 | .08 | 5.3 |  | 66.3 |  | 6.6 |  | 73.3 |  |
| 79 | .08 | 1.0 |  | 12.5 |  | 1.2 |  | 15.0 |  |
| 80 | .08 | 1.7 | 19.9 | 21.3 | 248.8 | 2.0 | 22.9 | 25.0 | 286.3 |
| 81 | .10 | 9.0 |  | 90.0 |  | 10.4 |  | 104.0 |  |
| 82 | .08 | 7.2 |  | 90.0 |  | 8.5 |  | 106.3 |  |

| ZONE | AREA (Sq.Mi.) | 1971 DAILY VEHICLE MILES (000) |  | 1971 VEHICLE MILES PER SQ. MI. (000) |  | 1977 DAILY VEHICLE MILES (000) |  | 1977 VEHICLE MILES PER SQ. MI. (000) |  |
|---|---|---|---|---|---|---|---|---|---|
|  |  | Streets | Frwys. | Streets | Frwys. | Streets | Frwys. | Streets | Frwys. |
| 83 | .07 | 8.6 |  | 122.9 |  | 9.9 |  | 141.4 |  |
| 84 | .08 | 3.2 |  | 40.0 |  | 3.7 |  | 46.3 |  |
| 85 | .09 | 15.1 |  | 167.8 |  | 17.4 |  | 193.3 |  |
| 86 | .09 | 6.3 |  | 70.0 |  | 7.1 |  | 78.9 |  |
| 87 | .09 | 9.3 |  | 103.3 |  | 11.0 |  | 122.2 |  |
| 88 | .17 | 8.2 |  | 48.2 |  | 10.3 |  | 60.6 |  |
| 89 | .17 | 4.7 |  | 27.6 |  | 5.6 |  | 32.9 |  |
| 90 | .07 | 5.8 | 14.8 | 82.9 | 211.4 | 6.7 | 17.0 | 95.7 | 242.9 |
| 91 | .07 | 8.3 |  | 118.6 |  | 9.5 |  | 135.7 |  |
| 92 | .07 | 11.1 |  | 158.6 |  | 12.8 |  | 182.9 |  |
| 93 | .06 | 12.6 |  | 210.0 |  | 14.5 |  | 241.7 |  |
| 94 | .07 | 7.0 |  | 100.0 |  | 8.1 |  | 115.7 |  |
| 95 | .07 | 7.6 |  | 108.6 |  | 8.7 |  | 124.3 |  |
| 96 | .07 | 16.5 |  | 235.7 |  | 19.0 |  | 271.4 |  |
| 97 | .07 | 7.2 |  | 102.9 |  | 8.3 |  | 118.6 |  |
| 98 | .07 | 11.0 |  | 157.1 |  | 13.2 |  | 188.6 |  |
| 99 | .04 | 2.5 |  | 62.5 |  | 3.0 |  | 75.0 |  |
| 100 | .10 | 5.0 |  | 51.0 |  | 6.0 |  | 60.0 |  |
| 101 | .10 | 11.6 |  | 116.0 |  | 13.7 |  | 137.0 |  |
| 102 | .11 | 12.3 |  | 111.8 |  | 14.5 |  | 131.8 |  |
| 103 | .10 | 2.7 |  | 27.0 |  | 3.2 |  | 32.0 |  |
| 104 | .10 | 5.1 |  | 51.0 |  | 6.0 |  | 60.0 |  |
| 105 | .10 | 16.4 |  | 164.0 |  | 19.4 |  | 194.0 |  |
| 106 | .10 | 7.7 |  | 77.0 |  | 9.1 |  | 91.0 |  |
| 107 | .10 | 12.4 |  | 124.0 |  | 15.5 |  | 155.0 |  |
| 108 | .15 | 4.5 |  | 30.0 |  | 5.6 |  | 37.3 |  |
| 109 | .08 | 1.0 |  | 12.5 |  | 1.2 |  | 15.0 |  |
| 110 | .07 | 7.0 |  | 100.0 |  | 8.3 |  | 118.6 |  |
| 111 | .06 | 6.9 |  | 115.0 |  | 8.1 |  | 135.0 |  |
| 112 | .06 | 10.5 |  | 175.0 |  | 12.4 |  | 206.7 |  |
| 113 | .07 | 7.3 |  | 104.3 |  | 8.6 |  | 122.9 |  |
| 114 | .06 | 6.4 |  | 106.7 |  | 7.6 |  | 126.7 |  |
| 115 | .06 | 11.2 |  | 186.7 |  | 13.2 |  | 220.0 |  |
| 116 | .07 | 8.4 |  | 120.0 |  | 9.9 |  | 141.4 |  |
| 117 | .09 | 6.1 |  | 67.8 |  | 7.3 |  | 81.1 |  |
| 118 | .10 | 4.4 |  | 44.0 |  | 5.3 |  | 53.0 |  |
| 119 | .11 | 7.5 |  | 68.2 |  | 9.0 |  | 81.8 |  |
| 120 | .11 | 13.4 |  | 121.8 |  | 16.0 |  | 146.4 |  |
| 121 | .10 | 5.0 |  | 50.0 |  | 6.0 |  | 60.0 |  |
| 122 | .11 | 3.8 |  | 34.5 |  | 4.6 |  | 41.8 |  |
| 123 | .11 | 13.1 |  | 119.1 |  | 15.7 |  | 142.7 |  |

| ZONE | AREA (Sq.Mi.) | 1971 DAILY VEHICLE MILES (000) Streets | 1971 DAILY VEHICLE MILES (000) Frwys. | 1971 VEHICLE MILES PER SQ. MI. (000) Streets | 1971 VEHICLE MILES PER SQ. MI. (000) Frwys. | 1977 DAILY VEHICLE MILES (000) Streets | 1977 DAILY VEHICLE MILES (000) Frwys. | 1977 VEHICLE MILES PER SQ. MI. (000) Streets | 1977 VEHICLE MILES PER SQ. MI. (000) Frwys |
|---|---|---|---|---|---|---|---|---|---|
| 123 | .11 | 13.1 | | 119.1 | | 15.7 | | 142.7 | |
| 124 | .10 | 7.1 | | 72.0 | | 8.5 | | 85.0 | |
| 125 | .08 | 4.6 | | 57.5 | | 5.5 | | 68.8 | |
| 126 | .14 | 11.7 | | 83.6 | | 14.0 | | 100.0 | |
| 127 | .13 | 29.5 | | 226.9 | | 35.4 | | 272.3 | |
| 128 | .11 | 13.1 | | 119.1 | | 15.7 | | 142.7 | |
| 129 | .12 | 24.3 | | 202.5 | | 29.2 | | 243.3 | |
| 130 | .13 | 7.9 | 18.3 | 60.8 | 140.8 | 9.5 | 22.0 | 73.1 | 169. |
| 131 | .14 | 20.0 | 16.3 | 142.9 | 116.4 | 24.0 | 19.6 | 171.4 | 140. |
| 132 | .20 | 9.9 | 20.1 | 49.5 | 100.5 | 11.9 | 24.1 | 59.5 | 120. |
| 133 | .08 | 17.2 | 14.4 | 215.0 | 180.0 | 20.6 | 17.3 | 257.5 | 216. |
| 134 | .19 | 2.6 | 11.3 | 13.7 | 59.5 | 3.1 | 13.6 | 16.3 | 71. |
| 135 | .15 | 0.6 | 89.6 | 4.0 | 593.3 | 0.7 | 107.5 | 4.7 | 716. |
| 136 | .28 | 11.0 | 48.7 | 39.3 | 173.9 | 13.8 | 60.9 | 49.3 | 217. |
| 137 | .14 | 10.0 | | 71.4 | | 12.0 | | 85.7 | |
| 138 | .15 | 16.9 | | 112.7 | | 20.3 | | 135.3 | |
| 139 | .12 | 21.3 | | 177.5 | | 25.6 | | 213.3 | |
| 140 | .14 | 9.8 | | 70.0 | | 11.8 | | 84.3 | |
| 141 | .13 | 2.7 | 19.9 | 20.8 | 153.1 | 3.2 | 23.9 | 24.6 | 183. |
| 142 | .12 | 12.0 | 16.1 | 100.0 | 134.2 | 14.4 | 19.3 | 120.0 | 160. |
| 143 | .14 | 17.9 | 17.7 | 127.9 | 126.4 | 21.5 | 21.2 | 153.6 | 151. |
| 144 | .11 | 4.8 | 17.7 | 43.6 | 160.9 | 5.8 | 21.2 | 52.7 | 192. |
| 145 | .53 | 31.5 | | 59.4 | | 37.8 | | 71.3 | |
| 146 | .59 | 18.9 | | 32.0 | | 25.5 | | 43.2 | |
| 147 | .59 | 22.3 | | 37.8 | | 29.0 | | 49.2 | |
| 148 | .59 | 19.5 | 10.4 | 33.1 | 17.6 | 24.4 | 13.0 | 41.4 | 22.0 |
| 149 | .77 | 47.6 | 3.1 | 61.8 | 4.0 | 59.5 | 3.9 | 77.3 | 5. |
| 150 | .54 | 42.2 | 20.2 | 78.1 | 37.4 | 52.8 | 25.3 | 97.8 | 46. |
| 151 | .54 | 31.6 | | 58.5 | | 39.5 | | 73.1 | |
| 152 | .54 | 23.9 | | 44.3 | | 27.5 | | 50.9 | |
| 153 | 1.00 | 7.7 | | 7.7 | | 9.6 | | 9.6 | |
| 154 | 1.00 | 43.4 | | 43.4 | | 56.4 | | 56.4 | |
| 155 | 1.00 | 40.7 | | 40.7 | | 49.9 | | 59.9 | |
| 156 | 1.00 | 33.9 | | 33.9 | | 41.5 | | 41.5 | |
| 157 | 1.42 | 57.3 | 36.6 | 40.4 | 25.8 | 70.2 | 44.8 | 49.4 | 31.5 |
| 158 | 1.00 | 39.8 | | 39.8 | | 55.7 | | 55.7 | |
| 159 | 1.00 | 28.9 | | 28.9 | | 39.0 | | 39.0 | |
| 160 | 1.00 | 32.1 | 12.0 | 32.1 | 12.0 | 40.1 | 15.0 | 40.1 | 15.0 |
| 161 | 1.00 | 43.5 | | 43.5 | | 54.4 | | 54.4 | |
| 162 | 1.00 | 18.9 | | 18.9 | | 22.7 | | 22.7 | |
| 163 | 1.06 | 11.8 | | 11.1 | | 14.2 | | 13.4 | |

| ZONE | AREA (Sq.Mi.) | 1971 DAILY VEHICLE MILES (000) |  | 1971 VEHICLE MILES PER SQ. MI. (000) |  | 1977 DAILY VEHICLE MILES (000) |  | 1977 VEHICLE MILES PER SQ. MI. (000) |  |
|---|---|---|---|---|---|---|---|---|---|
|  |  | Streets | Frwys. | Streets | Frwys. | Streets | Frwys. | Streets | Frwys. |
| 164 | 1.62 | 26.0 | 80.3 | 16.0 | 49.6 | 35.1 | 108.4 | 21.7 | 66.9 |
| 165 | 1.00 | 28.9 | 39.5 | 28.9 | 39.5 | 36.1 | 49.4 | 36.1 | 49.4 |
| 166 | 1.00 | 28.3 |  | 28.3 |  | 35.4 |  | 35.4 |  |
| 167 | 1.00 | 6.8 |  | 6.8 |  | 8.2 |  | 8.2 |  |
| 168 | 1.00 | 5.6 |  | 5.6 |  | 6.4 |  | 6.4 |  |
| 169 | 1.00 | 1.1 |  | 1.1 |  | 1.4 |  | 1.4 |  |
| 170 | 1.64 | 60.6 |  | 37.0 |  | 84.8 |  | 51.7 |  |
| 171 | 1.26 | 73.3 |  | 58.2 |  | 91.6 |  | 72.3 |  |
| 172 | 1.40 | 62.5 | 31.8 | 44.6 | 22.7 | 78.1 | 39.8 | 55.8 | 28.4 |
| 173 | 1.00 | 23.0 | 20.3 | 23.0 | 20.3 | 38.2 | 28.4 | 32.2 | 28.4 |
| 174 | 1.00 | 2.0 | 15.6 | 2.0 | 15.6 | 2.7 | 21.1 | 2.7 | 21.1 |
| 175 | 1.00 | 7.6 |  | 7.6 |  | 10.6 |  | 10.6 |  |
| 176 | 1.00 | 13.8 |  | 13.8 |  | 19.3 |  | 19.3 |  |
| 177 | 1.00 | 14.0 |  | 14.0 |  | 19.6 |  | 19.6 |  |
| 178 | 1.00 | 20.7 |  | 20.7 |  | 27.9 |  | 27.9 |  |
| 179 | 1.00 | 22.9 |  | 22.9 |  | 30.9 |  | 30.9 |  |
| 180 | 1.30 | 22.6 | 93.8 | 17.4 | 72.2 | 28.3 | 117.3 | 21.8 | 90.2 |
| 181 | 1.03 | 57.0 |  | 55.3 |  | 69.8 |  | 67.8 |  |
| 182 | .68 | 55.1 |  | 81.0 |  | 67.5 |  | 99.3 |  |
| 183 | .70 | 27.4 |  | 39.1 |  | 33.6 |  | 48.0 |  |
| 184 | 1.00 | 42.7 |  | 42.7 |  | 53.4 |  | 53.4 |  |
| 185 | 1.25 | 24.5 | 23.4 | 19.6 | 18.7 | 31.9 | 30.4 | 25.5 | 24.3 |
| 186 | 1.00 | 22.1 |  | 22.1 |  | 30.9 |  | 30.9 |  |
| 187 | 1.00 | 24.6 |  | 24.6 |  | 34.4 |  | 34.4 |  |
| 188 | 1.00 | 27.0 |  | 27.0 |  | 37.8 |  | 37.8 |  |
| 189 | 1.00 | 30.2 |  | 30.2 |  | 42.3 |  | 42.3 |  |
| 190 | 1.00 | 11.6 |  | 11.6 |  | 15.7 |  | 15.7 |  |
| 191 | 1.00 | 18.2 | 60.6 | 18.2 | 60.6 | 22.8 | 75.8 | 22.8 | 75.8 |
| 192 | 1.00 | 46.4 |  | 46.4 |  | 56.8 |  | 56.8 |  |
| 193 | 1.00 | 60.1 |  | 60.1 |  | 73.6 |  | 73.6 |  |
| 194 | 1.00 | 39.5 |  | 39.5 |  | 48.4 |  | 48.4 |  |
| 195 | 1.00 | 43.2 |  | 43.2 |  | 54.0 |  | 54.0 |  |
| 196 | 1.25 | 24.7 | 19.4 | 19.8 | 15.5 | 32.1 | 25.2 | 25.7 | 20.2 |
| 197 | 1.00 | 39.2 |  | 39.2 |  | 54.9 |  | 54.9 |  |
| 198 | 1.00 | 30.8 |  | 30.8 |  | 43.1 |  | 43.1 |  |
| 199 | 1.00 | 58.5 |  | 58.5 |  | 81.9 |  | 81.9 |  |
| 200 | 1.00 | 19.9 |  | 19.9 |  | 26.9 |  | 26.9 |  |
| 201 | 1.00 | 18.0 | 55.6 | 18.0 | 55.6 | 23.4 | 72.3 | 23.4 | 72.3 |
| 202 | 1.00 | 56.8 |  | 56.8 |  | 71.0 |  | 71.0 |  |
| 203 | 1.00 | 44.9 |  | 44.9 |  | 56.1 |  | 56.1 |  |
| 204 | 1.00 | 30.1 |  | 30.1 |  | 37.6 |  | 37.6 |  |
| 205 | 1.00 | 23.6 |  | 23.6 |  | 29.5 |  | 29.5 |  |

| ZONE | AREA (Sq.Mi.) | 1971 DAILY VEHICLE MILES (000) Streets | 1971 DAILY VEHICLE MILES (000) Frwys. | 1971 VEHICLE MILES PER SQ. MI. (000) Streets | 1971 VEHICLE MILES PER SQ. MI. (000) Frwys. | 1977 DAILY VEHICLE MILES (000) Streets | 1977 DAILY VEHICLE MILES (000) Frwys. | 1977 VEHICLE MILES PER SQ. MI. (000) Streets | 1977 VEHICLE MILES PER SQ. MI. (000) Frwys. |
|---|---|---|---|---|---|---|---|---|---|
| 206 | 1.00 | 28.0 | 16.2 | 28.0 | 16.2 | 36.4 | 21.1 | 36.4 | 21.1 |
| 207 | 1.00 | 19.7 | | 19.7 | | 27.6 | | 27.6 | |
| 208 | 1.00 | 3.6 | | 3.6 | | 4.9 | | 4.9 | |
| 209 | 1.00 | 8.6 | 47.6 | 8.6 | 47.6 | 11.2 | 61.9 | 11.2 | 61.9 |
| 210 | 1.00 | 40.6 | | 40.6 | | 52.8 | | 52.8 | |
| 211 | 1.00 | 48.9 | | 48.9 | | 63.6 | | 63.6 | |
| 212 | 1.00 | 26.4 | | 26.4 | | 34.3 | | 34.3 | |
| 213 | 1.00 | 23.4 | | 23.4 | | 30.4 | | 30.4 | |
| 214 | 1.00 | 5.2 | | 5.2 | | 6.8 | | 6.8 | |
| 215 | 1.00 | 22.4 | | 22.4 | | 31.4 | | 31.4 | |
| 216 | 1.00 | 0.4 | | 0.4 | | 0.5 | | 0.5 | |
| 217 | 1.00 | 18.5 | 38.2 | 18.5 | 38.2 | 25.0 | 51.6 | 25.0 | 51.6 |
| 218 | 1.00 | 28.5 | | 28.5 | | 38.5 | | 38.5 | |
| 219 | 1.00 | 53.6 | | 53.6 | | 72.4 | | 72.4 | |
| 220 | 1.00 | 32.5 | | 32.5 | | 42.3 | | 42.3 | |
| 221 | 1.00 | 1.0 | | 1.0 | | 1.4 | | 1.4 | |
| 222 | 1.00 | 7.4 | | 7.4 | | 10.0 | | 10.0 | |
| 223 | 1.00 | 3.4 | | 3.4 | | 4.8 | | 4.8 | |
| 224 | 1.00 | 2.0 | | 2.0 | | 2.8 | | 2.8 | |
| 225 | 1.00 | 3.9 | 39.8 | 3.9 | 39.8 | 5.4 | 54.7 | 5.4 | 54.7 |
| 226 | 1.00 | 20.2 | | 20.2 | | 27.8 | | 27.8 | |
| 227 | 1.00 | 18.5 | | 18.5 | | 25.4 | | 25.4 | |
| 228 | 1.00 | 11.0 | | 11.0 | | 15.1 | | 15.1 | |
| 229 | 1.00 | 27.8 | | 27.8 | | 38.2 | | 38.2 | |
| 230 | 1.00 | 4.6 | | 4.6 | | 6.4 | | 6.4 | |
| 231 | 1.00 | 12.6 | | 12.6 | | 17.6 | | 17.6 | |
| 232 | 1.00 | 8.3 | | 8.3 | | 11.6 | | 11.6 | |
| 233 | 1.00 | 26.4 | 28.3 | 26.4 | 28.3 | 37.0 | 39.6 | 37.0 | 39.6 |
| 234 | 1.00 | 25.8 | | 25.8 | | 36.1 | | 36.1 | |
| 235 | 1.00 | 19.8 | | 19.8 | | 27.7 | | 27.7 | |
| 236 | 1.00 | 0.8 | | 0.8 | | 1.1 | | 1.1 | |
| 237 | 1.00 | 18.4 | | 18.4 | | 25.8 | | 25.8 | |
| 238 | 1.00 | 6.9 | | 6.9 | | 9.7 | | 9.7 | |
| 239 | 1.00 | 5.6 | | 5.6 | | 7.8 | | 7.8 | |

# APPENDIX C

# TABULATIONS OF VEHICULAR EMISSIONS

## TABULATIONS OF VEHICULAR EMISSIONS

The computer printout sheets in the appendix provide a breakdown of emissions by vehicle type for the various zones as well as the total emissions for each zone which were presented in the body of the report.

The basic calculations (pages C-1- C-10) for the 24 zones were done in two steps:

1) Emissions from the city streets were calculated for each zone. Zone numbers from 1 to 24 on the printout sheets correspond sequentially to the zones from A to X in Figure II- 8.

2) Emissions from freeways were calculated for 10 zones. The correspondence between zone numbers on the printout sheets and the lettered zones for these calculations is: 1=A, 2=B, 3=F, 4=G, 5=L, 6=Q, 7=U, 8=V, 9=W and 10=X.

The calculations on page C-11 give the emissions for 12 zones in 1977 on the assumption that the Computer Central Signal Control System will be installed. The correspondence between the printout zone numbers and the lettered zones for these calculations is: 1=C, 2=D, 3=E, 4=H, 5=I, 6=J, 7-M, 8=N, 9=O, 10=R, 11-S, and 12=T.

The calculations on pages C-12 to C-15 are all for Zone H. The calculations indicated by Zone 1 assume no transportation control measure and the calculations indicated by Zone 2 assume that the Computer Central Signal Control System is in operation.

CITY OF SALT LAKE CALENDAR YEAR IS 1970

REGION NO. 2 POLLUTANT SPECIES IS CARBON MONOXIDE

MODEL YEARS CONSIDERED IS FROM 1958 TO 1971

LENGTH OF TIME PERIOD IS 8 HOURS

| VEHICLE CATEGORY - |  | LIGHT DUTY |  | HEAVY DUTY |  | OTHER |  | TOTAL |  |
|---|---|---|---|---|---|---|---|---|---|
| ZONE NO. | AREA (SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) |
| 1 | 0.270 | 1090.56 | 4039.10 | 13.95 | 51.68 | 0.0 | 0.0 | 1104.51 | 4090.78 |
| 2 | 0.810 | 3464.33 | 4276.95 | 56.25 | 69.44 | 0.0 | 0.0 | 3520.58 | 4346.39 |
| 3 | 0.780 | 5526.49 | 7085.24 | 98.55 | 126.34 | 0.0 | 0.0 | 5625.03 | 7211.58 |
| 4 | 0.840 | 4445.00 | 5291.66 | 84.45 | 100.53 | 0.0 | 0.0 | 4529.45 | 5392.20 |
| 5 | 0.280 | 870.59 | 3109.27 | 13.95 | 49.83 | 0.0 | 0.0 | 884.55 | 3159.10 |
| 6 | 0.270 | 833.93 | 3088.64 | 13.95 | 51.68 | 0.0 | 0.0 | 847.89 | 3140.32 |
| 7 | 0.810 | 3528.49 | 4356.16 | 56.25 | 69.44 | 0.0 | 0.0 | 3584.74 | 4425.60 |
| 8 | 0.810 | 6268.86 | 7739.34 | 112.65 | 139.07 | 0.0 | 0.0 | 6381.51 | 7878.40 |
| 9 | 0.810 | 5517.32 | 6811.51 | 98.55 | 121.66 | 0.0 | 0.0 | 5615.87 | 6933.17 |
| 10 | 0.270 | 1677.13 | 6211.58 | 28.05 | 103.90 | 0.0 | 0.0 | 1705.18 | 6315.48 |
| 11 | 0.180 | 485.66 | 2698.10 | 13.95 | 77.52 | 0.0 | 0.0 | 499.61 | 2775.62 |
| 12 | 0.660 | 1649.63 | 2499.44 | 28.05 | 42.50 | 0.0 | 0.0 | 1677.68 | 2541.95 |
| 13 | 0.730 | 3409.34 | 4670.33 | 56.25 | 77.05 | 0.0 | 0.0 | 3465.59 | 4747.38 |
| 14 | 0.750 | 3418.50 | 4558.00 | 56.25 | 75.00 | 0.0 | 0.0 | 3474.75 | 4633.00 |
| 15 | 0.250 | 1118.05 | 4472.21 | 13.95 | 55.81 | 0.0 | 0.0 | 1132.01 | 4528.02 |
| 16 | 0.320 | 485.66 | 1517.68 | 13.95 | 43.60 | 0.0 | 0.0 | 499.61 | 1561.29 |
| 17 | 0.900 | 1072.23 | 1191.36 | 13.95 | 15.50 | 0.0 | 0.0 | 1086.18 | 1206.87 |
| 18 | 0.820 | 2969.41 | 3621.24 | 56.25 | 68.60 | 0.0 | 0.0 | 3025.66 | 3689.83 |
| 19 | 0.810 | 3051.90 | 3767.78 | 56.25 | 69.44 | 0.0 | 0.0 | 3108.15 | 3837.22 |
| 20 | 0.270 | 888.92 | 3292.31 | 13.95 | 51.68 | 0.0 | 0.0 | 902.88 | 3343.99 |
| 21 | 0.550 | 916.42 | 1666.22 | 13.95 | 25.37 | 0.0 | 0.0 | 930.37 | 1691.59 |
| 22 | 0.780 | 3180.21 | 4077.19 | 56.25 | 72.12 | 0.0 | 0.0 | 3236.46 | 4149.31 |
| 23 | 0.850 | 3546.82 | 4172.73 | 56.25 | 66.18 | 0.0 | 0.0 | 3603.07 | 4238.90 |
| 24 | 0.200 | 1594.64 | 7973.20 | 28.05 | 140.26 | 0.0 | 0.0 | 1622.69 | 8113.46 |
|  |  |  |  |  |  |  |  |  |  |
| 1 | 0.270 | 394.67 | 1461.74 | 21.82 | 80.83 | 0.0 | 0.0 | 416.49 | 1542.57 |
| 2 | 0.810 | 284.44 | 351.16 | 16.35 | 20.19 | 0.0 | 0.0 | 300.79 | 371.35 |
| 3 | 0.270 | 622.25 | 2304.63 | 32.76 | 121.35 | 0.0 | 0.0 | 655.01 | 2425.98 |
| 4 | 0.810 | 380.45 | 469.69 | 16.35 | 20.19 | 0.0 | 0.0 | 396.80 | 489.88 |
| 5 | 0.660 | 1141.41 | 1729.42 | 54.64 | 82.79 | 1.96 | 2.97 | 1198.02 | 1815.18 |
| 6 | 0.900 | 1475.67 | 1639.64 | 76.52 | 85.03 | 1.96 | 2.18 | 1554.16 | 1726.84 |
| 7 | 0.550 | 1002.73 | 1823.15 | 49.17 | 89.41 | 0.0 | 0.0 | 1051.91 | 1912.56 |
| 8 | 0.780 | 753.82 | 966.44 | 38.23 | 49.02 | 0.0 | 0.0 | 792.05 | 1015.45 |
| 9 | 0.850 | 800.05 | 941.23 | 38.23 | 44.98 | 0.0 | 0.0 | 838.28 | 986.21 |
| 10 | 0.200 | 209.76 | 1048.81 | 10.88 | 54.42 | 0.0 | 0.0 | 220.65 | 1103.23 |

CITY OF SALT LAKE CALENDAR YEAR IS 1971

REGION NO. 2 POLLUTANT SPECIES IS CARBON MONOXIDE

MODEL YEARS CONSIDERED IS FROM 1959 TO 1972

LENGTH OF TIME PERIOD IS 8 HOURS

| VEHICLE CATEGORY - |  | LIGHT DUTY |  | HEAVY DUTY |  | OTHER |  | TOTAL |  |
|---|---|---|---|---|---|---|---|---|---|
| ZONE NO. | AREA (SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) |
| 1 | 0.270 | 1064.17 | 3941.38 | 14.16 | 52.43 | 0.0 | 0.0 | 1078.33 | 3993.80 |
| 2 | 0.810 | 3380.31 | 4173.22 | 56.62 | 69.90 | 0.0 | 0.0 | 3436.93 | 4243.13 |
| 3 | 0.780 | 5392.40 | 6913.34 | 99.09 | 127.03 | 0.0 | 0.0 | 5491.48 | 7040.36 |
| 4 | 0.840 | 4337.17 | 5163.30 | 84.93 | 101.11 | 0.0 | 0.0 | 4422.10 | 5264.41 |
| 5 | 0.280 | 849.55 | 3034.11 | 14.16 | 50.55 | 0.0 | 0.0 | 863.70 | 3084.66 |
| 6 | 0.270 | 813.78 | 3014.00 | 14.16 | 52.43 | 0.0 | 0.0 | 827.93 | 3066.42 |
| 7 | 0.810 | 3442.91 | 4250.50 | 56.62 | 69.90 | 0.0 | 0.0 | 3499.53 | 4320.41 |
| 8 | 0.810 | 6116.75 | 7551.55 | 113.24 | 139.80 | 0.0 | 0.0 | 6229.99 | 7691.35 |
| 9 | 0.810 | 5383.46 | 6646.25 | 99.09 | 122.33 | 0.0 | 0.0 | 5482.54 | 6768.57 |
| 10 | 0.270 | 1636.50 | 6061.11 | 28.31 | 104.85 | 0.0 | 0.0 | 1664.81 | 6165.96 |
| 11 | 0.180 | 473.96 | 2633.11 | 14.16 | 78.66 | 0.0 | 0.0 | 488.11 | 2711.75 |
| 12 | 0.660 | 1609.67 | 2438.90 | 28.31 | 42.89 | 0.0 | 0.0 | 1637.98 | 2481.79 |
| 13 | 0.730 | 3326.66 | 4557.06 | 56.62 | 77.56 | 0.0 | 0.0 | 3383.28 | 4634.63 |
| 14 | 0.750 | 3335.60 | 4447.46 | 56.62 | 75.49 | 0.0 | 0.0 | 3392.22 | 4522.96 |
| 15 | 0.250 | 1091.00 | 4364.00 | 14.16 | 56.62 | 0.0 | 0.0 | 1105.16 | 4420.62 |
| 16 | 0.320 | 473.96 | 1481.12 | 14.16 | 44.23 | 0.0 | 0.0 | 488.11 | 1525.36 |
| 17 | 0.900 | 1046.29 | 1162.54 | 14.16 | 15.73 | 0.0 | 0.0 | 1060.44 | 1178.27 |
| 18 | 0.820 | 2897.41 | 3533.43 | 56.62 | 69.05 | 0.0 | 0.0 | 2954.03 | 3602.48 |
| 19 | 0.810 | 2977.89 | 3676.41 | 56.62 | 69.90 | 0.0 | 0.0 | 3034.51 | 3746.31 |
| 20 | 0.270 | 867.43 | 3212.72 | 14.16 | 52.43 | 0.0 | 0.0 | 881.59 | 3265.15 |
| 21 | 0.550 | 894.26 | 1625.93 | 14.16 | 25.74 | 0.0 | 0.0 | 908.42 | 1651.67 |
| 22 | 0.780 | 3103.09 | 3978.32 | 56.62 | 72.59 | 0.0 | 0.0 | 3159.71 | 4050.91 |
| 23 | 0.850 | 3460.80 | 4071.53 | 56.62 | 66.61 | 0.0 | 0.0 | 3517.42 | 4138.14 |
| 24 | 0.200 | 1556.02 | 7780.08 | 28.31 | 141.55 | 0.0 | 0.0 | 1584.33 | 7921.63 |
|  |  |  |  |  |  |  |  |  |  |
| 1 | 0.270 | 385.12 | 1426.39 | 21.97 | 81.36 | 0.0 | 0.0 | 407.09 | 1507.75 |
| 2 | 0.810 | 277.57 | 342.68 | 16.48 | 20.34 | 0.0 | 0.0 | 294.04 | 363.02 |
| 3 | 0.270 | 607.18 | 2248.81 | 32.95 | 122.04 | 0.0 | 0.0 | 640.13 | 2370.85 |
| 4 | 0.810 | 371.25 | 458.33 | 16.48 | 20.34 | 0.0 | 0.0 | 387.72 | 478.67 |
| 5 | 0.660 | 1113.74 | 1687.48 | 54.92 | 83.21 | 2.04 | 3.09 | 1170.70 | 1773.78 |
| 6 | 0.900 | 1439.88 | 1599.87 | 76.89 | 85.43 | 2.04 | 2.27 | 1518.81 | 1687.56 |
| 7 | 0.550 | 978.42 | 1778.95 | 49.43 | 89.87 | 0.0 | 0.0 | 1027.85 | 1868.82 |
| 8 | 0.780 | 735.55 | 943.02 | 38.44 | 49.29 | 0.0 | 0.0 | 774.00 | 992.30 |
| 9 | 0.850 | 780.66 | 918.42 | 38.44 | 45.23 | 0.0 | 0.0 | 819.10 | 963.65 |
| 10 | 0.200 | 204.71 | 1023.53 | 10.98 | 54.92 | 0.0 | 0.0 | 215.69 | 1078.45 |

CITY OF SALT LAKE CALENDAR YEAR IS 1977

REGION NO. 2 POLLUTANT SPECIES IS CARBON MONOXIDE

MODEL YEARS CONSIDERED IS FROM 1965 TO 1978

LENGTH OF TIME PERIOD IS 8 HOURS

| VEHICLE CATEGORY - | | LIGHT DUTY | | HEAVY DUTY | | OTHER | | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| ZONE NO. | AREA (SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.M |
| 1 | 0.270 | 604.15 | 2237.58 | 20.99 | 77.75 | 0.0 | 0.0 | 625.14 | 2315.33 |
| 2 | 0.810 | 1832.72 | 2262.61 | 52.4P | 64.79 | 0.0 | 0.0 | 1885.20 | 2327.41 |
| 3 | 0.780 | 2895.04 | 3711.59 | 83.97 | 107.66 | 0.0 | 0.0 | 2979.02 | 3819.25 |
| 4 | 0.840 | 2270.62 | 2703.12 | 62.98 | 74.97 | 0.0 | 0.0 | 2333.60 | 2778.10 |
| 5 | 0.280 | 450.07 | 1607.39 | 10.50 | 37.49 | 0.0 | 0.0 | 460.57 | 1644.88 |
| 6 | 0.270 | 462.23 | 1711.98 | 10.50 | 38.88 | 0.0 | 0.0 | 472.73 | 1750.85 |
| 7 | 0.P10 | 1P32.72 | 2262.61 | 52.48 | 64.79 | 0.0 | 0.0 | 1885.20 | 2327.41 |
| 8 | 0.810 | 3272.13 | 4039.67 | 94.47 | 116.63 | 0.0 | 0.0 | 3366.60 | 4156.29 |
| 9 | 0.810 | 2765.29 | 3413.94 | 83.97 | 103.67 | 0.0 | 0.0 | 2849.27 | 3517.61 |
| 10 | 0.270 | 875.81 | 3243.75 | 31.49 | 116.63 | 0.0 | 0.0 | 907.30 | 3360.37 |
| 11 | 0.180 | 267.61 | 1486.72 | 10.50 | 58.31 | 0.0 | 0.0 | 278.11 | 1545.03 |
| 12 | 0.660 | 843.37 | 1277.84 | 20.99 | 31.81 | 0.0 | 0.0 | 864.37 | 1309.65 |
| 13 | 0.730 | 1743.51 | 23PP.3P | 52.48 | 71.89 | 0.0 | 0.0 | 1796.00 | 2460.27 |
| 14 | 0.750 | 1735.40 | 2313.87 | 52.48 | 69.98 | 0.0 | 0.0 | 17P7.P9 | 23P3.P5 |
| 15 | 0.250 | 587.93 | 2351.72 | 20.99 | 83.97 | 0.0 | 0.0 | 608.92 | 2435.69 |
| 16 | 0.320 | 271.66 | 848.95 | 10.50 | 32.80 | 0.0 | 0.0 | 282.16 | 881.75 |
| 17 | 0.900 | 563.60 | 626.22 | 20.99 | 23.33 | 0.0 | 0.0 | 584.59 | 649.55 |
| 18 | 0.820 | 1561.05 | 1903.72 | 41.99 | 51.20 | 0.0 | 0.0 | 1603.04 | 1954.93 |
| 19 | 0.P10 | 1601.60 | 1977.2P | 52.48 | 64.79 | 0.0 | 0.0 | 1654.08 | 2042.08 |
| 20 | 0.270 | 482.51 | 1787.06 | 10.50 | 38.88 | 0.0 | 0.0 | 493.00 | 1P25.94 |
| 21 | 0.550 | 494.67 | 899.40 | 10.50 | 19.08 | 0.0 | 0.0 | 505.17 | 918.49 |
| 22 | 0.780 | 1694.86 | 2172.89 | 52.48 | 67.28 | 0.0 | 0.0 | 1747.34 | 2240.18 |
| 23 | 0.850 | 1881.37 | 2213.38 | 52.48 | 61.74 | 0.0 | 0.0 | 1933.85 | 2275.12 |
| 24 | 0.200 | 847.43 | 4237.14 | 20.99 | 104.96 | 0.0 | 0.0 | 868.42 | 4342.11 |
| | | | | | | | | | |
| 1 | 0.270 | 226.69 | 839.58 | 27.08 | 100.29 | 0.0 | 0.0 | 253.76 | 939.87 |
| 2 | 0.810 | 162.62 | 200.77 | 16.25 | 20.06 | 0.0 | 0.0 | 178.87 | 220.83 |
| 3 | 0.270 | 359.74 | 1332.3P | 37.91 | 140.40 | 0.0 | 0.0 | 397.65 | 1472.78 |
| 4 | 0.810 | 210.26 | 259.58 | 21.66 | 26.74 | 0.0 | 0.0 | 231.92 | 2P6.32 |
| 5 | 0.660 | 616.00 | 933.33 | 64.99 | 98.46 | 2.04 | 3.09 | 683.02 | 1034.88 |
| 6 | 0.900 | 818.04 | 908.94 | 86.65 | 96.27 | 2.04 | 2.27 | 906.73 | 1007.40 |
| 7 | 0.550 | 571.65 | 1039.36 | 59.57 | 108.31 | 2.04 | 3.71 | 633.26 | 1151.37 |
| 8 | 0.780 | 417.24 | 534.92 | 43.32 | 55.54 | 0.0 | 0.0 | 460.56 | 590.46 |
| 9 | 0.P50 | 443.52 | 521.79 | 4P.74 | 57.34 | 2.04 | 2.40 | 494.30 | 581.53 |
| 10 | 0.200 | 116.63 | 583.14 | 10.83 | 54.15 | 0.0 | 0.0 | 127.46 | 637.30 |

CITY OF SALT LAKE                CALENDAR YEAR IS 1978

REGION NO. 2                POLLUTANT SPECIES IS CARBON MONOXIDE

MODEL YEARS CONSIDERED IS FROM 1966 TO 1979

LENGTH OF TIME PERIOD IS 8 HOURS

| VEHICLE CATEGORY - |  | LIGHT DUTY |  | HEAVY DUTY |  | OTHER |  | TOTAL |  |
|---|---|---|---|---|---|---|---|---|---|
| ZONE NO. | AREA (SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) |
| 1 | 0.270 | 512.36 | 1897.62 | 19.78 | 73.25 | 0.0 | 0.0 | 532.14 | 1970.87 |
| 2 | 0.810 | 1543.73 | 1905.84 | 49.44 | 61.04 | 0.0 | 0.0 | 1593.17 | 1966.88 |
| 3 | 0.780 | 2435.37 | 3122.27 | 79.11 | 101.42 | 0.0 | 0.0 | 2514.47 | 3223.68 |
| 4 | 0.840 | 1903.05 | 2265.53 | 69.22 | 82.40 | 0.0 | 0.0 | 1972.26 | 2347.93 |
| 5 | 0.280 | 379.28 | 1354.57 | 9.89 | 35.32 | 0.0 | 0.0 | 389.17 | 1389.88 |
| 6 | 0.270 | 392.59 | 1454.02 | 9.89 | 36.62 | 0.0 | 0.0 | 402.47 | 1490.65 |
| 7 | 0.810 | 1543.73 | 1905.84 | 49.44 | 61.04 | 0.0 | 0.0 | 1593.17 | 1966.88 |
| 8 | 0.810 | 2754.76 | 3400.94 | 89.00 | 109.87 | 0.0 | 0.0 | 2843.75 | 3510.81 |
| 9 | 0.810 | 2312.27 | 2854.65 | 79.11 | 97.66 | 0.0 | 0.0 | 2391.37 | 2952.31 |
| 10 | 0.270 | 735.27 | 2723.21 | 29.67 | 109.87 | 0.0 | 0.0 | 764.93 | 2833.08 |
| 11 | 0.180 | 226.24 | 1256.87 | 39.55 | 219.74 | 0.0 | 0.0 | 265.79 | 1476.61 |
| 12 | 0.660 | 708.65 | 1073.71 | 19.78 | 29.96 | 0.0 | 0.0 | 728.43 | 1103.68 |
| 13 | 0.730 | 1460.55 | 2000.76 | 49.44 | 67.73 | 0.0 | 0.0 | 1510.00 | 2068.49 |
| 14 | 0.750 | 1453.90 | 1938.53 | 49.44 | 65.92 | 0.0 | 0.0 | 1503.34 | 2004.46 |
| 15 | 0.250 | 495.72 | 1982.89 | 19.78 | 79.11 | 0.0 | 0.0 | 515.50 | 2062.00 |
| 16 | 0.320 | 229.56 | 717.39 | 9.89 | 30.90 | 0.0 | 0.0 | 239.45 | 748.29 |
| 17 | 0.900 | 475.76 | 528.62 | 19.78 | 21.97 | 0.0 | 0.0 | 495.54 | 550.60 |
| 18 | 0.820 | 1314.17 | 1602.64 | 49.44 | 60.29 | 0.0 | 0.0 | 1363.61 | 1662.94 |
| 19 | 0.810 | 1347.44 | 1663.50 | 49.44 | 61.04 | 0.0 | 0.0 | 1396.88 | 1724.54 |
| 20 | 0.270 | 409.22 | 1515.64 | 9.89 | 36.62 | 0.0 | 0.0 | 419.11 | 1552.26 |
| 21 | 0.550 | 419.20 | 762.19 | 9.89 | 17.98 | 0.0 | 0.0 | 429.09 | 780.16 |
| 22 | 0.780 | 1427.28 | 1829.85 | 49.44 | 63.39 | 0.0 | 0.0 | 1476.73 | 1893.24 |
| 23 | 0.850 | 1586.98 | 1867.04 | 49.44 | 58.17 | 0.0 | 0.0 | 1636.42 | 1925.20 |
| 24 | 0.200 | 715.31 | 3576.53 | 19.78 | 98.88 | 0.0 | 0.0 | 735.08 | 3675.41 |
|  |  |  |  |  |  |  |  |  |  |
| 1 | 0.270 | 198.21 | 734.11 | 28.00 | 103.71 | 0.0 | 0.0 | 226.21 | 837.82 |
| 2 | 0.810 | 141.38 | 174.54 | 16.80 | 20.74 | 0.0 | 0.0 | 158.18 | 195.29 |
| 3 | 0.270 | 313.26 | 1160.21 | 39.20 | 145.19 | 0.0 | 0.0 | 352.46 | 1305.40 |
| 4 | 0.810 | 182.96 | 225.88 | 22.40 | 27.66 | 0.0 | 0.0 | 205.36 | 253.54 |
| 5 | 0.660 | 532.26 | 806.45 | 72.80 | 110.31 | 2.04 | 3.09 | 607.10 | 919.85 |
| 6 | 0.900 | 709.68 | 788.53 | 95.20 | 105.78 | 2.04 | 2.27 | 806.92 | 896.58 |
| 7 | 0.550 | 498.99 | 907.26 | 67.20 | 122.19 | 2.04 | 3.71 | 568.23 | 1033.15 |
| 8 | 0.780 | 361.77 | 463.81 | 44.80 | 57.44 | 0.0 | 0.0 | 406.57 | 521.24 |
| 9 | 0.850 | 383.95 | 451.70 | 50.40 | 59.30 | 0.0 | 0.0 | 434.35 | 511.00 |
| 10 | 0.200 | 101.18 | 505.92 | 11.20 | 56.00 | 0.0 | 0.0 | 112.38 | 561.92 |

CITY OF SALT LAKE CALENDAR YEAR IS 1979

REGION NO. 2 POLLUTANT SPECIES IS CARBON MONOXIDE

MODEL YEARS CONSIDERED IS FROM 1967 TO 1980

LENGTH OF TIME PERIOD IS 8 HOURS

| VEHICLE CATEGORY - | | LIGHT DUTY | | HEAVY DUTY | | OTHER | | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| ZONE NO. | AREA (SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) |
| 1 | 0.270 | 434.36 | 1608.75 | 18.57 | 68.79 | 0.0 | 0.0 | 452.94 | 1677.54 |
| 2 | 0.810 | 1303.09 | 1608.75 | 46.43 | 57.33 | 0.0 | 0.0 | 1349.52 | 1666.08 |
| 3 | 0.780 | 2051.61 | 2630.28 | 83.58 | 107.16 | 0.0 | 0.0 | 2135.20 | 2737.43 |
| 4 | 0.840 | 1598.13 | 1902.53 | 65.01 | 77.39 | 0.0 | 0.0 | 1663.14 | 1979.92 |
| 5 | 0.280 | 319.63 | 1141.52 | 9.29 | 33.17 | 0.0 | 0.0 | 328.91 | 1174.69 |
| 6 | 0.270 | 333.28 | 1234.39 | 9.29 | 34.40 | 0.0 | 0.0 | 342.57 | 1268.78 |
| 7 | 0.810 | 1297.63 | 1602.01 | 46.43 | 57.33 | 0.0 | 0.0 | 1344.06 | 1659.33 |
| 8 | 0.810 | 2316.60 | 2860.00 | 92.87 | 114.65 | 0.0 | 0.0 | 2409.47 | 2974.66 |
| 9 | 0.810 | 1934.15 | 2387.83 | 74.29 | 91.72 | 0.0 | 0.0 | 2008.44 | 2479.56 |
| 10 | 0.270 | 617.40 | 2286.65 | 27.86 | 103.19 | 0.0 | 0.0 | 645.26 | 2389.84 |
| 11 | 0.180 | 191.23 | 1062.38 | 9.29 | 51.59 | 0.0 | 0.0 | 200.52 | 1113.98 |
| 12 | 0.660 | 595.54 | 902.34 | 18.57 | 28.14 | 0.0 | 0.0 | 614.12 | 930.48 |
| 13 | 0.730 | 1262.11 | 1728.92 | 46.43 | 63.61 | 0.0 | 0.0 | 1308.55 | 1792.53 |
| 14 | 0.750 | 1218.40 | 1624.54 | 46.43 | 61.91 | 0.0 | 0.0 | 1264.84 | 1686.45 |
| 15 | 0.250 | 417.97 | 1671.89 | 18.57 | 74.29 | 0.0 | 0.0 | 436.55 | 1746.18 |
| 16 | 0.320 | 193.96 | 606.13 | 9.29 | 29.02 | 0.0 | 0.0 | 203.25 | 635.15 |
| 17 | 0.900 | 401.58 | 446.20 | 18.57 | 20.64 | 0.0 | 0.0 | 420.15 | 466.84 |
| 18 | 0.820 | 1106.40 | 1349.26 | 46.43 | 56.63 | 0.0 | 0.0 | 1152.83 | 1405.89 |
| 19 | 0.810 | 1133.71 | 1399.65 | 46.43 | 57.33 | 0.0 | 0.0 | 1180.15 | 1456.97 |
| 20 | 0.270 | 344.21 | 1274.86 | 9.29 | 34.40 | 0.0 | 0.0 | 353.50 | 1309.26 |
| 21 | 0.550 | 352.41 | 640.74 | 9.29 | 16.89 | 0.0 | 0.0 | 361.69 | 657.63 |
| 22 | 0.780 | 1204.74 | 1544.54 | 46.43 | 59.53 | 0.0 | 0.0 | 1251.18 | 1604.07 |
| 23 | 0.850 | 1338.60 | 1574.83 | 55.72 | 65.55 | 0.0 | 0.0 | 1394.32 | 1640.38 |
| 24 | 0.200 | 603.74 | 3018.69 | 27.86 | 139.30 | 0.0 | 0.0 | 631.60 | 3157.99 |
| | | | | | | | | | |
| 1 | 0.270 | 174.18 | 645.13 | 28.52 | 105.61 | 0.0 | 0.0 | 202.70 | 750.74 |
| 2 | 0.810 | 124.42 | 153.60 | 17.11 | 21.12 | 0.0 | 0.0 | 141.53 | 174.72 |
| 3 | 0.270 | 276.09 | 1022.55 | 45.62 | 168.98 | 0.0 | 0.0 | 321.71 | 1191.53 |
| 4 | 0.810 | 159.96 | 197.49 | 22.81 | 28.16 | 0.0 | 0.0 | 182.78 | 225.65 |
| 5 | 0.660 | 465.68 | 705.57 | 74.14 | 112.33 | 2.04 | 3.09 | 541.86 | 820.99 |
| 6 | 0.900 | 622.09 | 691.21 | 96.95 | 107.72 | 2.04 | 2.27 | 721.08 | 801.20 |
| 7 | 0.550 | 439.61 | 799.29 | 68.44 | 124.43 | 2.04 | 3.71 | 510.08 | 927.43 |
| 8 | 0.780 | 316.38 | 405.61 | 51.33 | 65.80 | 0.0 | 0.0 | 367.70 | 471.41 |
| 9 | 0.850 | 337.70 | 397.30 | 51.33 | 60.39 | 0.0 | 0.0 | 389.03 | 457.68 |
| 10 | 0.200 | 88.87 | 444.35 | 11.41 | 57.03 | 0.0 | 0.0 | 100.28 | 501.38 |

CITY OF SALT LAKE CALENDAR YEAR IS 1970

REGION NO. 2 POLLUTANT SPECIES IS HYDROCARBONS

MODEL YEARS CONSIDERED IS FROM 1958 TO 1971

LENGTH OF TIME PERIOD IS 3 HOURS

| VEHICLE CATEGORY - |  | LIGHT DUTY |  | HEAVY DUTY |  | OTHER |  | TOTAL |  |
|---|---|---|---|---|---|---|---|---|---|
| ZONE NO. | AREA (SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) |
| 1 | 0.270 | 67.69 | 250.69 | 2.74 | 10.15 | 0.0 | 0.0 | 70.43 | 260.83 |
| 2 | 0.810 | 215.78 | 266.39 | 8.28 | 10.22 | 0.0 | 0.0 | 224.06 | 276.61 |
| 3 | 0.780 | 344.13 | 441.19 | 11.05 | 14.16 | 0.0 | 0.0 | 355.17 | 455.35 |
| 4 | 0.840 | 276.43 | 329.08 | 8.28 | 9.85 | 0.0 | 0.0 | 284.70 | 338.93 |
| 5 | 0.280 | 53.58 | 191.36 | 2.74 | 9.79 | 0.0 | 0.0 | 56.32 | 201.15 |
| 6 | 0.270 | 52.17 | 193.22 | 2.74 | 10.15 | 0.0 | 0.0 | 54.91 | 203.37 |
| 7 | 0.810 | 220.01 | 271.62 | 8.28 | 10.22 | 0.0 | 0.0 | 228.29 | 281.83 |
| 8 | 0.810 | 389.26 | 480.57 | 13.81 | 17.05 | 0.0 | 0.0 | 403.07 | 497.62 |
| 9 | 0.810 | 342.72 | 423.11 | 11.05 | 13.64 | 0.0 | 0.0 | 353.76 | 436.74 |
| 10 | 0.270 | 104.36 | 386.50 | 2.74 | 10.15 | 0.0 | 0.0 | 107.10 | 396.65 |
| 11 | 0.180 | 29.60 | 164.47 | 0.0 | 0.0 | 0.0 | 0.0 | 29.60 | 164.47 |
| 12 | 0.660 | 102.95 | 155.98 | 2.74 | 4.15 | 0.0 | 0.0 | 105.69 | 160.13 |
| 13 | 0.730 | 211.55 | 289.79 | 8.28 | 11.34 | 0.0 | 0.0 | 219.82 | 301.13 |
| 14 | 0.750 | 212.96 | 283.94 | 8.28 | 11.04 | 0.0 | 0.0 | 221.23 | 294.96 |
| 15 | 0.250 | 69.10 | 276.38 | 2.74 | 10.96 | 0.0 | 0.0 | 71.84 | 287.34 |
| 16 | 0.320 | 31.01 | 96.92 | 0.0 | 0.0 | 0.0 | 0.0 | 31.01 | 96.92 |
| 17 | 0.900 | 66.27 | 73.64 | 2.74 | 3.04 | 0.0 | 0.0 | 69.01 | 76.68 |
| 18 | 0.820 | 184.75 | 225.30 | 5.51 | 6.72 | 0.0 | 0.0 | 190.26 | 232.02 |
| 19 | 0.810 | 188.98 | 233.31 | 5.51 | 6.80 | 0.0 | 0.0 | 194.49 | 240.11 |
| 20 | 0.270 | 54.99 | 203.67 | 2.74 | 10.15 | 0.0 | 0.0 | 57.73 | 213.82 |
| 21 | 0.550 | 56.40 | 102.55 | 2.74 | 4.98 | 0.0 | 0.0 | 59.14 | 107.53 |
| 22 | 0.780 | 197.44 | 253.13 | 5.51 | 7.06 | 0.0 | 0.0 | 202.95 | 260.19 |
| 23 | 0.850 | 220.01 | 258.83 | 8.28 | 9.74 | 0.0 | 0.0 | 228.29 | 268.57 |
| 24 | 0.200 | 98.71 | 493.57 | 2.74 | 13.70 | 0.0 | 0.0 | 101.45 | 507.27 |
|  |  |  |  |  |  |  |  |  |  |
| 1 | 0.270 | 38.14 | 141.27 | 3.18 | 11.77 | 0.0 | 0.0 | 41.32 | 153.04 |
| 2 | 0.810 | 27.74 | 34.24 | 3.16 | 3.92 | 0.0 | 0.0 | 30.92 | 38.17 |
| 3 | 0.270 | 60.69 | 224.77 | 6.37 | 23.61 | 0.0 | 0.0 | 67.06 | 248.38 |
| 4 | 0.810 | 37.28 | 46.02 | 3.18 | 3.92 | 0.0 | 0.0 | 40.45 | 49.94 |
| 5 | 0.660 | 110.98 | 168.15 | 11.17 | 16.92 | 0.0 | 0.0 | 122.15 | 185.07 |
| 6 | 0.900 | 143.06 | 158.96 | 14.36 | 15.96 | 0.0 | 0.0 | 157.42 | 174.91 |
| 7 | 0.550 | 97.97 | 178.13 | 9.57 | 17.40 | 0.0 | 0.0 | 107.54 | 195.53 |
| 8 | 0.780 | 72.83 | 93.37 | 6.37 | 8.17 | 0.0 | 0.0 | 79.20 | 101.54 |
| 9 | 0.850 | 78.03 | 91.80 | 7.97 | 9.38 | 0.0 | 0.0 | 86.00 | 101.18 |
| 10 | 0.200 | 20.80 | 104.01 | 1.58 | 7.91 | 0.0 | 0.0 | 22.38 | 111.91 |

CITY OF SALT LAKE          CALENDAR YEAR IS 1971

REGION NO. 2          POLLUTANT SPECIES IS HYDROCARBUNS

MODEL YEARS CONSIDERED IS FROM 1959 TO 1972

LENGTH OF TIME PERIOD IS    3 HOURS

| VEHICLE CATEGORY - | | LIGHT DUTY | | HEAVY DUTY | | OTHER | | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| ZONE NO. | AREA (SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) |
| 1 | 0.270 | 63.51 | 235.21 | 2.77 | 10.27 | 0.0 | 0.0 | 66.28 | 245.49 |
| 2 | 0.810 | 202.43 | 249.91 | 8.32 | 10.27 | 0.0 | 0.0 | 210.75 | 260.19 |
| 3 | 0.780 | 322.83 | 413.89 | 11.10 | 14.23 | 0.0 | 0.0 | 333.93 | 428.11 |
| 4 | 0.840 | 259.32 | 308.72 | 8.32 | 9.91 | 0.0 | 0.0 | 267.65 | 318.63 |
| 5 | 0.280 | 50.28 | 179.56 | 2.77 | 9.91 | 0.0 | 0.0 | 53.05 | 189.47 |
| 6 | 0.270 | 48.95 | 181.31 | 2.77 | 10.27 | 0.0 | 0.0 | 51.73 | 191.59 |
| 7 | 0.810 | 206.40 | 254.81 | 8.32 | 10.27 | 0.0 | 0.0 | 214.72 | 265.09 |
| 8 | 0.810 | 365.17 | 450.83 | 13.87 | 17.12 | 0.0 | 0.0 | 379.04 | 467.95 |
| 9 | 0.810 | 321.51 | 396.92 | 11.10 | 13.70 | 0.0 | 0.0 | 332.60 | 410.62 |
| 10 | 0.270 | 97.91 | 362.62 | 2.77 | 10.27 | 0.0 | 0.0 | 100.68 | 372.90 |
| 11 | 0.180 | 27.78 | 154.36 | 0.0 | 0.0 | 0.0 | 0.0 | 27.78 | 154.36 |
| 12 | 0.660 | 96.58 | 146.34 | 2.77 | 4.20 | 0.0 | 0.0 | 99.36 | 150.54 |
| 13 | 0.730 | 198.46 | 271.86 | 8.32 | 11.40 | 0.0 | 0.0 | 206.78 | 283.27 |
| 14 | 0.750 | 199.78 | 266.38 | 8.32 | 11.10 | 0.0 | 0.0 | 208.11 | 277.46 |
| 15 | 0.250 | 64.83 | 259.32 | 2.77 | 11.10 | 0.0 | 0.0 | 67.60 | 270.42 |
| 16 | 0.320 | 29.11 | 90.96 | 0.0 | 0.0 | 0.0 | 0.0 | 29.11 | 90.96 |
| 17 | 0.900 | 62.18 | 69.09 | 2.77 | 3.08 | 0.0 | 0.0 | 64.96 | 72.18 |
| 18 | 0.820 | 173.32 | 211.37 | 5.55 | 6.77 | 0.0 | 0.0 | 178.87 | 218.14 |
| 19 | 0.810 | 177.29 | 218.88 | 5.55 | 6.85 | 0.0 | 0.0 | 182.84 | 225.73 |
| 20 | 0.270 | 51.60 | 191.11 | 2.77 | 10.27 | 0.0 | 0.0 | 54.37 | 201.39 |
| 21 | 0.550 | 52.92 | 96.22 | 2.77 | 5.04 | 0.0 | 0.0 | 55.70 | 101.27 |
| 22 | 0.780 | 185.23 | 237.48 | 5.55 | 7.11 | 0.0 | 0.0 | 190.78 | 244.59 |
| 23 | 0.850 | 206.40 | 242.82 | 8.32 | 9.79 | 0.0 | 0.0 | 214.72 | 252.61 |
| 24 | 0.200 | 92.62 | 463.08 | 2.77 | 13.97 | 0.0 | 0.0 | 95.39 | 476.95 |
| | | | | | | | | | |
| 1 | 0.270 | 35.40 | 131.11 | 3.16 | 11.70 | 0.0 | 0.0 | 38.56 | 142.81 |
| 2 | 0.810 | 25.75 | 31.78 | 3.16 | 3.90 | 0.0 | 0.0 | 28.91 | 35.69 |
| 3 | 0.270 | 56.32 | 208.59 | 6.32 | 23.40 | 0.0 | 0.0 | 62.64 | 231.99 |
| 4 | 0.810 | 34.60 | 42.71 | 3.16 | 3.90 | 0.0 | 0.0 | 37.76 | 46.61 |
| 5 | 0.660 | 102.98 | 156.04 | 11.06 | 16.75 | 0.0 | 0.0 | 114.04 | 172.79 |
| 6 | 0.900 | 132.75 | 147.50 | 14.22 | 15.80 | 0.0 | 0.0 | 146.97 | 163.30 |
| 7 | 0.550 | 90.92 | 165.30 | 9.48 | 17.23 | 0.0 | 0.0 | 100.39 | 182.53 |
| 8 | 0.780 | 67.58 | 86.64 | 6.32 | 8.10 | 0.0 | 0.0 | 73.90 | 94.75 |
| 9 | 0.850 | 72.41 | 85.19 | 7.90 | 9.29 | 0.0 | 0.0 | 80.31 | 94.48 |
| 10 | 0.200 | 19.31 | 96.55 | 1.58 | 7.90 | 0.0 | 0.0 | 20.89 | 104.45 |

CITY OF SALT LAKE CALENDAR YEAR IS 1977

REGION NO. 2 POLLUTANT SPECIES IS HYDROCARBONS

MODEL YEARS CONSIDERED IS FROM 1965 TO 1978

LENGTH OF TIME PERIOD IS 3 HOURS

| VEHICLE CATEGORY - | | LIGHT DUTY | | HEAVY DUTY | | OTHER | | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| ZONE NO. | AREA (SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSIUN DENSITY (KGM/SQ.MI) |
| 1 | 0.270 | 30.98 | 114.73 | 1.88 | 6.98 | 0.0 | 0.0 | 32.86 | 121.71 |
| 2 | 0.810 | 94.48 | 116.64 | 5.65 | 6.98 | 0.0 | 0.0 | 100.13 | 123.62 |
| 3 | 0.780 | 149.21 | 191.29 | 9.42 | 12.08 | 0.0 | 0.0 | 158.63 | 203.37 |
| 4 | 0.840 | 116.68 | 138.91 | 7.54 | 8.97 | 0.0 | 0.0 | 124.22 | 147.88 |
| 5 | 0.280 | 23.23 | 82.98 | 1.88 | 6.73 | 0.0 | 0.0 | 25.12 | 89.70 |
| 6 | 0.270 | 23.75 | 87.96 | 1.88 | 6.98 | 0.0 | 0.0 | 25.63 | 94.94 |
| 7 | 0.810 | 94.48 | 116.64 | 5.65 | 6.98 | 0.0 | 0.0 | 100.13 | 123.62 |
| 8 | 0.810 | 168.31 | 207.79 | 11.30 | 13.96 | 0.0 | 0.0 | 179.62 | 221.75 |
| 9 | 0.810 | 142.50 | 175.92 | 9.42 | 11.63 | 0.0 | 0.0 | 151.92 | 187.55 |
| 10 | 0.270 | 44.92 | 166.36 | 3.77 | 13.96 | 0.0 | 0.0 | 48.69 | 180.32 |
| 11 | 0.180 | 13.94 | 77.44 | 1.88 | 10.47 | 0.0 | 0.0 | 15.82 | 87.91 |
| 12 | 0.660 | 43.37 | 65.71 | 3.77 | 5.71 | 0.0 | 0.0 | 47.14 | 71.42 |
| 13 | 0.730 | 89.83 | 123.06 | 5.65 | 7.74 | 0.0 | 0.0 | 95.49 | 130.80 |
| 14 | 0.750 | 89.32 | 119.09 | 5.65 | 7.54 | 0.0 | 0.0 | 94.97 | 126.63 |
| 15 | 0.250 | 30.46 | 121.84 | 1.88 | 7.54 | 0.0 | 0.0 | 32.35 | 129.38 |
| 16 | 0.320 | 13.94 | 43.56 | 1.88 | 5.89 | 0.0 | 0.0 | 15.82 | 49.45 |
| 17 | 0.900 | 28.91 | 32.12 | 1.88 | 2.09 | 0.0 | 0.0 | 30.80 | 34.22 |
| 18 | 0.820 | 80.54 | 98.22 | 1.88 | 2.30 | 0.0 | 0.0 | 82.43 | 100.52 |
| 19 | 0.810 | 92.61 | 101.98 | 5.65 | 6.98 | 0.0 | 0.0 | 98.26 | 108.96 |
| 20 | 0.270 | 24.78 | 91.79 | 1.88 | 6.98 | 0.0 | 0.0 | 26.67 | 98.76 |
| 21 | 0.550 | 25.30 | 46.00 | 1.88 | 3.43 | 0.0 | 0.0 | 27.18 | 49.42 |
| 22 | 0.780 | 87.25 | 111.86 | 5.65 | 7.25 | 0.0 | 0.0 | 92.91 | 119.11 |
| 23 | 0.850 | 97.06 | 114.19 | 5.65 | 6.65 | 0.0 | 0.0 | 102.71 | 120.84 |
| 24 | 0.200 | 43.88 | 219.42 | 3.77 | 18.84 | 0.0 | 0.0 | 47.65 | 238.26 |
| | | | | | | | | | |
| 1 | 0.270 | 16.69 | 61.83 | 3.57 | 13.21 | 0.0 | 0.0 | 20.26 | 75.04 |
| 2 | 0.810 | 11.84 | 14.61 | 2.38 | 2.94 | 0.0 | 0.0 | 14.22 | 17.55 |
| 3 | 0.270 | 26.41 | 97.81 | 5.94 | 22.01 | 0.0 | 0.0 | 32.35 | 119.82 |
| 4 | 0.810 | 15.48 | 19.11 | 3.57 | 4.40 | 0.0 | 0.0 | 19.05 | 23.51 |
| 5 | 0.660 | 45.53 | 68.99 | 9.51 | 14.41 | 0.0 | 0.0 | 55.04 | 83.39 |
| 6 | 0.900 | 60.40 | 67.12 | 11.89 | 13.21 | 0.0 | 0.0 | 72.63 | 80.70 |
| 7 | 0.550 | 42.19 | 76.71 | 8.32 | 15.13 | 0.34 | 0.37 | 50.51 | 91.84 |
| 8 | 0.780 | 30.66 | 39.30 | 5.94 | 7.62 | 0.0 | 0.0 | 36.60 | 46.92 |
| 9 | 0.850 | 32.78 | 38.57 | 7.13 | 8.39 | 0.0 | 0.0 | 39.91 | 46.96 |
| 10 | 0.200 | 8.50 | 42.50 | 2.38 | 11.89 | 0.0 | 0.0 | 10.88 | 54.38 |

CITY OF SALT LAKE CALENDAR YEAR IS 1978

REGION NO. 2 UTANT SPECIES IS HYDROCARBONS

MODEL YEARS CONSIDERED IS FROM 1966 TO 1979

LENGTH OF TIME PERIOD IS 3 HOURS

| VEHICLE CATEGORY - | | LIGHT DUTY | | HEAVY DUTY | | OTHER | | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| ZONE NO. | AREA (SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) |
| 1 | 0.270 | 26.74 | 99.03 | 1.75 | 6.49 | 0.0 | 0.0 | 28.49 | 105.52 |
| 2 | 0.810 | 81.08 | 100.10 | 5.26 | 6.49 | 0.0 | 0.0 | 86.34 | 106.59 |
| 3 | 0.780 | 127.66 | 163.66 | 8.76 | 11.23 | 0.0 | 0.0 | 136.42 | 174.90 |
| 4 | 0.840 | 99.62 | 118.60 | 7.01 | 8.35 | 0.0 | 0.0 | 106.63 | 126.95 |
| 5 | 0.280 | 19.84 | 70.85 | 1.75 | 6.26 | 0.0 | 0.0 | 21.59 | 77.11 |
| 6 | 0.270 | 20.70 | 76.67 | 1.75 | 6.49 | 0.0 | 0.0 | 22.45 | 83.16 |
| 7 | 0.810 | 80.65 | 99.57 | 5.26 | 6.49 | 0.0 | 0.0 | 85.91 | 106.06 |
| 8 | 0.810 | 144.48 | 178.37 | 10.52 | 12.98 | 0.0 | 0.0 | 154.99 | 191.35 |
| 9 | 0.810 | 121.19 | 149.61 | 8.76 | 10.82 | 0.0 | 0.0 | 129.95 | 160.43 |
| 10 | 0.270 | 38.38 | 142.16 | 3.51 | 12.98 | 0.0 | 0.0 | 41.89 | 155.14 |
| 11 | 0.180 | 12.08 | 67.09 | 0.0 | 0.0 | 0.0 | 0.0 | 12.08 | 67.09 |
| 12 | 0.660 | 37.09 | 56.20 | 3.51 | 5.31 | 0.0 | 0.0 | 40.59 | 61.51 |
| 13 | 0.730 | 76.77 | 105.16 | 5.26 | 7.20 | 0.0 | 0.0 | 82.02 | 112.36 |
| 14 | 0.750 | 76.34 | 101.78 | 5.26 | 7.01 | 0.0 | 0.0 | 81.59 | 108.79 |
| 15 | 0.250 | 25.88 | 103.51 | 1.75 | 7.01 | 0.0 | 0.0 | 27.63 | 110.52 |
| 16 | 0.320 | 12.08 | 37.74 | 0.0 | 0.0 | 0.0 | 0.0 | 12.08 | 37.74 |
| 17 | 0.900 | 25.01 | 27.79 | 1.75 | 1.95 | 0.0 | 0.0 | 26.77 | 29.74 |
| 18 | 0.820 | 69.00 | 84.15 | 5.26 | 6.41 | 0.0 | 0.0 | 74.26 | 90.56 |
| 19 | 0.810 | 70.73 | 87.32 | 5.26 | 6.49 | 0.0 | 0.0 | 75.99 | 93.81 |
| 20 | 0.270 | 21.56 | 79.87 | 1.75 | 6.49 | 0.0 | 0.0 | 23.32 | 86.36 |
| 21 | 0.550 | 21.99 | 39.99 | 1.75 | 3.19 | 0.0 | 0.0 | 23.75 | 43.18 |
| 22 | 0.780 | 73.32 | 94.00 | 5.26 | 6.74 | 0.0 | 0.0 | 78.57 | 100.74 |
| 23 | 0.850 | 83.24 | 97.92 | 5.26 | 6.19 | 0.0 | 0.0 | 88.49 | 104.11 |
| 24 | 0.200 | 37.52 | 187.60 | 3.51 | 17.53 | 0.0 | 0.0 | 41.03 | 205.13 |
| | | | | | | | | | |
| 1 | 0.270 | 14.64 | 54.20 | 3.51 | 13.00 | 0.0 | 0.0 | 18.14 | 67.20 |
| 2 | 0.810 | 10.53 | 13.00 | 2.34 | 2.89 | 0.0 | 0.0 | 12.87 | 15.89 |
| 3 | 0.270 | 23.11 | 85.59 | 5.85 | 21.67 | 0.0 | 0.0 | 28.96 | 107.25 |
| 4 | 0.810 | 13.61 | 16.80 | 3.51 | 4.33 | 0.0 | 0.0 | 17.12 | 21.13 |
| 5 | 0.660 | 39.28 | 59.52 | 9.36 | 14.18 | 0.0 | 0.0 | 48.64 | 73.70 |
| 6 | 0.900 | 52.38 | 58.20 | 12.87 | 14.30 | 0.0 | 0.0 | 65.58 | 72.87 |
| 7 | 0.550 | 36.97 | 67.22 | 9.36 | 17.02 | 0.34 | 0.37 | 46.33 | 84.24 |
| 8 | 0.780 | 26.70 | 34.23 | 5.85 | 7.50 | 0.0 | 0.0 | 32.55 | 41.73 |
| 9 | 0.850 | 28.50 | 33.53 | 7.02 | 8.26 | 0.0 | 0.0 | 35.52 | 41.79 |
| 10 | 0.200 | 7.45 | 37.23 | 2.34 | 11.70 | 0.0 | 0.0 | 9.79 | 48.93 |

CITY OF SALT LAKE CALENDAR YEAR IS 1979

REGION NO. 2 POLLUTANT SPECIES IS HYDROCARBONS

MODEL YEARS CONSIDERED IS FROM 1967 TO 1980

LENGTH OF TIME PERIOD IS 3 HOURS

| VEHICLE CATEGORY - | | LIGHT DUTY | | HEAVY DUTY | | OTHER | | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| ZONE NO. | AREA (SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) |
| 1 | 0.270 | 22.66 | 83.92 | 1.63 | 6.03 | 0.0 | 0.0 | 24.29 | 89.95 |
| 2 | 0.810 | 68.33 | 84.35 | 4.89 | 6.03 | 0.0 | 0.0 | 73.21 | 90.39 |
| 3 | 0.780 | 107.27 | 137.53 | 8.14 | 10.44 | 0.0 | 0.0 | 115.41 | 147.96 |
| 4 | 0.840 | 83.90 | 99.89 | 6.51 | 7.75 | 0.0 | 0.0 | 90.42 | 107.64 |
| 5 | 0.280 | 16.64 | 59.43 | 1.63 | 5.82 | 0.0 | 0.0 | 18.27 | 65.24 |
| 6 | 0.270 | 17.35 | 64.25 | 1.63 | 6.03 | 0.0 | 0.0 | 18.98 | 70.28 |
| 7 | 0.810 | 67.97 | 83.92 | 4.89 | 6.03 | 0.0 | 0.0 | 72.86 | 89.95 |
| 8 | 0.810 | 121.43 | 149.91 | 9.77 | 12.06 | 0.0 | 0.0 | 131.20 | 161.98 |
| 9 | 0.810 | 101.25 | 125.00 | 8.14 | 10.05 | 0.0 | 0.0 | 109.39 | 135.05 |
| 10 | 0.270 | 32.57 | 120.63 | 3.26 | 12.05 | 0.0 | 0.0 | 35.83 | 132.59 |
| 11 | 0.180 | 9.91 | 55.07 | 1.63 | 9.05 | 0.0 | 0.0 | 11.54 | 64.12 |
| 12 | 0.660 | 31.15 | 47.20 | 3.26 | 4.93 | 0.0 | 0.0 | 34.41 | 52.14 |
| 13 | 0.730 | 66.20 | 90.69 | 4.89 | 6.69 | 0.0 | 0.0 | 71.09 | 97.38 |
| 14 | 0.750 | 63.72 | 84.97 | 4.89 | 6.51 | 0.0 | 0.0 | 68.61 | 91.48 |
| 15 | 0.250 | 21.95 | 87.80 | 1.63 | 6.51 | 0.0 | 0.0 | 23.58 | 94.31 |
| 16 | 0.320 | 10.27 | 32.08 | 1.63 | 5.09 | 0.0 | 0.0 | 11.90 | 37.17 |
| 17 | 0.900 | 20.89 | 23.21 | 1.63 | 1.81 | 0.0 | 0.0 | 22.52 | 25.02 |
| 18 | 0.820 | 58.05 | 70.91 | 4.89 | 5.96 | 0.0 | 0.0 | 62.95 | 76.76 |
| 19 | 0.810 | 59.48 | 73.43 | 4.89 | 6.03 | 0.0 | 0.0 | 64.36 | 79.46 |
| 20 | 0.270 | 18.06 | 66.87 | 1.63 | 6.03 | 0.0 | 0.0 | 19.68 | 72.90 |
| 21 | 0.550 | 18.41 | 33.47 | 1.63 | 2.96 | 0.0 | 0.0 | 20.04 | 36.43 |
| 22 | 0.780 | 63.02 | 80.79 | 4.89 | 6.26 | 0.0 | 0.0 | 67.90 | 87.05 |
| 23 | 0.850 | 70.10 | 82.47 | 4.89 | 5.75 | 0.0 | 0.0 | 74.96 | 88.22 |
| 24 | 0.200 | 31.51 | 157.54 | 3.26 | 16.29 | 0.0 | 0.0 | 34.77 | 173.53 |
| | | | | | | | | | |
| 1 | 0.270 | 12.61 | 46.70 | 3.43 | 12.72 | 0.0 | 0.0 | 16.04 | 59.42 |
| 2 | 0.810 | 8.98 | 11.08 | 2.29 | 2.83 | 0.0 | 0.0 | 11.27 | 13.91 |
| 3 | 0.270 | 19.88 | 73.62 | 5.72 | 21.20 | 0.0 | 0.0 | 25.60 | 94.81 |
| 4 | 0.810 | 11.54 | 14.25 | 3.43 | 4.24 | 0.0 | 0.0 | 14.97 | 18.49 |
| 5 | 0.660 | 33.55 | 50.84 | 9.16 | 13.87 | 0.0 | 0.0 | 42.71 | 64.71 |
| 6 | 0.900 | 44.88 | 49.87 | 12.59 | 13.99 | 0.34 | 0.37 | 57.81 | 64.23 |
| 7 | 0.550 | 31.63 | 57.51 | 9.16 | 16.65 | 0.0 | 0.0 | 40.79 | 74.16 |
| 8 | 0.780 | 22.87 | 29.32 | 6.87 | 8.80 | 0.0 | 0.0 | 29.74 | 38.12 |
| 9 | 0.850 | 24.36 | 28.66 | 6.87 | 8.08 | 0.0 | 0.0 | 31.23 | 36.74 |
| 10 | 0.200 | 6.41 | 32.06 | 2.29 | 11.45 | 0.0 | 0.0 | 8.70 | 43.50 |

CITY OF SALT LAKE          CALENDAR YEAR IS 1977

REGION NO. 2          POLLUTANT SPECIES IS CARBON MONOXIDE

MODEL YEARS CONSIDERED IS FROM 1965 TO 1978

LENGTH OF TIME PERIOD IS     8 HOURS

| VEHICLE CATEGORY - | | LIGHT DUTY | | HEAVY DUTY | | OTHER | | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| ZONE NO. | AREA (SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) |
| 1 | 0.780 | 2415.21 | 3096.43 | 72.65 | 93.14 | 0.0 | 0.0 | 2487.86 | 3189.56 |
| 2 | 0.840 | 1894.29 | 2255.10 | 54.48 | 64.86 | 0.0 | 0.0 | 1948.77 | 2319.96 |
| 3 | 0.280 | 375.47 | 1340.98 | 9.08 | 32.43 | 0.0 | 0.0 | 384.55 | 1373.41 |
| 4 | 0.810 | 2729.80 | 3370.12 | 81.73 | 100.90 | 0.0 | 0.0 | 2811.53 | 3471.02 |
| 5 | 0.810 | 2306.97 | 2848.11 | 72.65 | 89.69 | 0.0 | 0.0 | 2379.61 | 2937.80 |
| 6 | 0.270 | 730.65 | 2706.12 | 27.24 | 100.90 | 0.0 | 0.0 | 757.90 | 2807.02 |
| 7 | 0.730 | 1454.54 | 1992.52 | 45.40 | 62.20 | 0.0 | 0.0 | 1499.94 | 2054.72 |
| 8 | 0.750 | 1447.77 | 1930.37 | 45.40 | 60.54 | 0.0 | 0.0 | 1493.18 | 1990.90 |
| 9 | 0.250 | 490.48 | 1961.94 | 18.16 | 72.65 | 0.0 | 0.0 | 508.65 | 2034.58 |
| 10 | 0.820 | 1302.32 | 1588.20 | 36.32 | 44.30 | 0.0 | 0.0 | 1338.64 | 1632.49 |
| 11 | 0.810 | 1336.15 | 1649.57 | 45.40 | 56.05 | 0.0 | 0.0 | 1381.55 | 1705.62 |
| 12 | 0.270 | 402.54 | 1490.87 | 9.08 | 33.63 | 0.0 | 0.0 | 411.62 | 1524.50 |

```
              CITY OF SALT LAKE          CALENDAR YEAR IS 1972
              REGION NO.  2          POLLUTANT SPECIES IS CARBON MONOXIDE
              MODEL YEARS CONSIDERED IS FROM 1960 TO 1973
              LENGTH OF TIME PERIOD IS     8 HOURS

  VEHICLE
  CATEGORY -     LIGHT DUTY            HEAVY DUTY             OTHER                 TOTAL
ZONE  AREA  EMISSIONS  EMISSION    EMISSIONS  EMISSION    EMISSIONS  EMISSION    EMISSIONS  EMISSION
NO.                    DENSITY                DENSITY                DENSITY                DENSITY
     (SQ.MI)  (KGM)   (KGM/SQ.MI)   (KGM)    (KGM/SQ.MI)   (KGM)    (KGM/SQ.MI)   (KGM)    (KGM/SQ.MI)

 1   0.810   5775.42   7134.14     112.70     139.14       0.0        0.0       5888.12    7269.28
 2   0.810   4790.61   5914.33      93.48     115.41       0.0        0.0       4884.09    6029.73

              CITY OF SALT LAKE          CALENDAR YEAR IS 1973
              REGION NO.  2          POLLUTANT SPECIES IS CARBON MONOXIDE
              MODEL YEARS CONSIDERED IS FROM 1961 TO 1974
              LENGTH OF TIME PERIOD IS     8 HOURS

  VEHICLE
  CATEGORY -     LIGHT DUTY            HEAVY DUTY             OTHER                 TOTAL
ZONE  AREA  EMISSIONS  EMISSION    EMISSIONS  EMISSION    EMISSIONS  EMISSION    EMISSIONS  EMISSION
NO.                    DENSITY                DENSITY                DENSITY                DENSITY
     (SQ.MI)  (KGM)   (KGM/SQ.MI)   (KGM)    (KGM/SQ.MI)   (KGM)    (KGM/SQ.MI)   (KGM)    (KGM/SQ.MI)

 1   0.810   5351.55   6606.86     113.45     140.06       0.0        0.0       5465.00    6746.92
 2   0.810   4439.02   5480.27      94.11     116.18       0.0        0.0       4533.12    5596.45
```

CITY OF SALT LAKE          CALENDAR YEAR IS 1974

REGION NO. 2          POLLUTANT SPECIES IS CARBON MONOXIDE

MODEL YEARS CONSIDERED IS FROM 1962 TO 1975

LENGTH OF TIME PERIOD IS    8 HOURS

| VEHICLE CATEGORY - | | LIGHT DUTY | | HEAVY DUTY | | OTHER | | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| ZONE NO. | AREA (SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) |
| 1 | 0.810 | 4926.58 | 6082.20 | 111.07 | 137.12 | 0.0 | 0.0 | 5037.64 | 6219.31 |
| 2 | 0.810 | 4086.72 | 5045.33 | 92.19 | 113.81 | 0.0 | 0.0 | 4178.90 | 5159.14 |

CITY OF SALT LAKE          CALENDAR YEAR IS 1975

REGION NO. 2          POLLUTANT SPECIES IS CARBON MONOXIDE

MODEL YEARS CONSIDERED IS FROM 1963 TO 1976

LENGTH OF TIME PERIOD IS    8 HOURS

| VEHICLE CATEGORY - | | LIGHT DUTY | | HEAVY DUTY | | OTHER | | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| ZONE NO. | AREA (SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) | EMISSIONS (KGM) | EMISSION DENSITY (KGM/SQ.MI) |
| 1 | 0.810 | 4450.83 | 5494.85 | 105.08 | 129.73 | 0.0 | 0.0 | 4555.91 | 5624.58 |
| 2 | 0.810 | 3694.93 | 4561.64 | 87.94 | 108.57 | 0.0 | 0.0 | 3782.87 | [illegible] |

```
                 CITY OF SALT LAKE          CALENDAR YEAR IS 1976

                 REGION NO. 2          POLLUTANT SPECIES IS CARBON MONOXIDE

                 MODEL YEARS CONSIDERED IS FROM 1964 TO 1977

                 LENGTH OF TIME PERIOD IS    8 HOURS

 VEHICLE
 CATEGORY -    LIGHT DUTY           HEAVY DUTY            OTHER                  TOTAL

ZONE   AREA  EMISSIONS   EMISSION   EMISSIONS   EMISSION   EMISSIONS   EMISSION     EMISSIONS   EMISSION
NO.                      DENSITY                DENSITY                DENSITY                  DENSITY
      (SQ.MI)  (KGM)   (KGM/SQ.MI)   (KGM)   (KGM/SQ.MI)   (KGM)   (KGM/SQ.MI)     (KGM)    (KGM/SQ.MI)


 1   0.810    3798.63   4689.66       99.26    122.54        0.0         0.0        3897.89    4812.21
 2   0.810    3159.96   3901.19       84.44    104.24        0.0         0.0        3244.40    4005.43

                 CITY OF SALT LAKE          CALENDAR YEAR IS 1977

                 REGION NO. 2          POLLUTANT SPECIES IS CARBON MONOXIDE

                 MODEL YEARS CONSIDERED IS FROM 1965 TO 1978

                 LENGTH OF TIME PERIOD IS    8 HOURS

 VEHICLE
 CATEGORY -    LIGHT DUTY           HEAVY DUTY            OTHER                  TOTAL

ZONE   AREA  EMISSIONS   EMISSION   EMISSIONS   EMISSION   EMISSIONS   EMISSION     EMISSIONS   EMISSION
NO.                      DENSITY                DENSITY                DENSITY                  DENSITY
      (SQ.MI)  (KGM)   (KGM/SQ.MI)   (KGM)   (KGM/SQ.MI)   (KGM)   (KGM/SQ.MI)     (KGM)    (KGM/SQ.MI)


 1   0.810    3272.13   4039.67       94.47    116.63        0.0         0.0        3366.60    4156.29
 2   0.810    2729.80   3370.12       81.73    100.90        0.0         0.0        2811.53    3471.02
```

```
                CITY OF SALT LAKE             CALENDAR YEAR IS 1978

                REGION NO.  2           POLLUTANT SPECIES IS CARBON MONOXIDE

                MODEL YEARS CONSIDERED IS FROM 1966 TO 1979

                LENGTH OF TIME PERIOD IS    8 HOURS

 VEHICLE
 CATEGORY -    LIGHT DUTY             HEAVY DUTY                 OTHER                      TOTAL

ZONE  AREA  EMISSIONS  EMISSION    EMISSIONS  EMISSION    EMISSIONS  EMISSION      EMISSIONS  EMISSION
NO.                    DENSITY                DENSITY                DENSITY                  DENSITY
     (SQ.MI)  (KGM)   (KGM/SQ.MI)   (KGM)   (KGM/SQ.MI)   (KGM)    (KGM/SQ.MI)     (KGM)    (KGM/SQ.MI)

 1   0.810   2754.76   3400.94      89.00     109.87       0.0        0.0         2843.75    3510.81
 2   0.810   2307.00   2848.15      78.24      96.60       0.0        0.0         2385.24    2944.74

                CITY OF SALT LAKF             CALENDAR YEAR IS 1979

                REGION NO.  2           POLLUTANT SPECIES IS CARBON MONOXIDE

                MODEL YEARS CONSIDERED IS FROM 1967 TO 1980

                LENGTH OF TIME PERIOD IS    8 HOURS

 VEHICLE
 CATEGORY -    LIGHT DUTY             HEAVY DUTY                 OTHER                      TOTAL

ZONE  AREA  EMISSIONS  EMISSION    EMISSIONS  EMISSION    EMISSIONS  EMISSION      EMISSIONS  EMISSION
NO.                    DENSITY                DENSITY                DENSITY                  DENSITY
     (SQ.MI)  (KGM)   (KGM/SQ.MI)   (KGM)   (KGM/SQ.MI)   (KGM)    (KGM/SQ.MI)     (KGM)    (KGM/SQ.MI)

 1   0.810   2316.60   2860.00      92.87     114.65       0.0        0.0         2409.47    2974.66
 2   0.810   1951.12   2408.79      82.88     102.33       0.0        0.0         2034.00    2511.11
```

# APPENDIX D

## QUESTIONNAIRE - TESTING THE FEASIBILITY OF CONTROL STRATEGIES

## APPENDIX D: TESTING THE FEASIBILITY OF SELECTED TRANSPORTATION CONTROL STRATEGIES

1. Which of the selected control strategies do you think the automobile owners of the Salt Lake City area would find most acceptable? Which least acceptable? Rank your response in order of their potential acceptability from 1 (most acceptable) to 8 (least acceptable).

   Motor Vehicle Inspection Programs ____
   Traffic Flow Improvements ____
   Peripheral Parking ____
   Improved Mass Transit ____
   Prohibitions on Traffic at Certain Times in Specific Areas ____
   Restricted Curb Parking ____
   Staggered Work Hours ____
   Car Pooling ____

2. Assuming sufficient public acceptance for some transportation control strategy, what do you feel are the two most signficant barriers to implementation:

   Lack of funding for initial capitalization ____
   Low inter-governmental cooperation ____
   Negative impact upon local business ____
   Inadequate planning capacity ____
   Increased cost to local government for operation of the program ____
   Other ____________ ____

3. Please explain your answer to #2. ____________

4. Which public and private agencies and organizations do you feel must play an essential role in planning a traffic flow improvement program?

   ____________

5. How would you describe the public's present awareness of air pollution and air quality issues? ____________

   Very well developed ____ Moderately aware ____
   Little awareness of this problem ____

6. If the driving public were supportive and the funds were readily available, which transportation control strategy would you personally favor and why? ____________

# APPENDIX E

# LIST OF INTERVIEWEES

## APPENDIX E: LIST OF INTERVIEWEES

| | |
|---|---|
| Wilbur R. Jefferies | Director of Transportation, Wasatch Front Regional Council |
| David D. Brumitt | Research Analyst - Transportation, State Planning Coordinator's Office |
| William L. Fields | President, Utah Transit Authority<br>Manager, Transportation Council, Salt Lake Area Chamber of Commerce |
| Ronald L. Bouck | Director of Community Affairs, Salt Lake Area Chamber of Commerce |
| William Oswald | State Legislative Counselor |
| William Davis | Investigator, Salt Lake City/County Health Dept., Air Pollution Division |
| Ralph McClure | County Commissioner, Salt Lake County |
| Jess Agraz | City Traffic Engineer, City of Salt Lake |
| Les Jester | Chief, Planning and Programs, Utah State Department of Highways |
| Richard Hudspeth | Utah State Division of Health, Air Quality Section |
| John Lord | Consultant, Utah State Transportation Study |